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METAL INDUSTRY
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More Research on Electrodeposition Needed

At the recent meeting of the Electrochemical Society, the scarcity of good technical papers on electrodeposition was very evident. The practical workers engaged in the electrodeposition of metals know all too well that there are many problems which would warrant the intensive study of research workers, and they wonder at the paucity of study on these problems.

One of the reasons for the rather limited amount of research work on electrodeposition is that only a handful of university laboratories conduct systematic research, due either to the unfamiliarity of research directors with the electrodeposition industry, or because of the false and unwarranted belief that electrodeposition problems are too shallow and not worthy of intensive study by erudite research men.

They assume that the determination of the vapor pressure of mercury to the sixth decimal place or a study of activity coefficients fraught with doubtful assumptions and for worthlessly dilute concentrations, are of far greater value as scientific achievements, than the study, for example, of porosity in coatings, the mechanism of electrodeposition, or a rationalization of the effects of addition agents.

One research worker recently stated that he discarded a problem the minute the slightest practical value could be associated with the problem under consideration. While it is true that often seemingly valueless scientific discoveries have resulted in the basis for the creation of new tools for the boon of mankind, it appears to be unwise to direct all research towards a nebulous end.

The Bureau of Standards has published some notable and practically valuable fundamental work on corrosion resistance of electrodeposits, current distribution, thickness determination of coatings and on complex salts. The staff at the Bureau of Standards, ably headed by Dr. William Blum, has published a creditable number of papers in spite of the small personnel and the many demands of routine problems. W.P.A. money wasted on historical surveys and other trivia could very profitably be diverted to research at the Bureau of Standards.

Research projects at universities will shortly start, and let us hope that the science of electrodeposition will begin to receive from research students the full measure of attention to which it is entitled.

On the American Electroplaters' Society Proceedings

The members of the American Electroplaters' Society were pleasantly surprised by the receipt of the volume on the Annual Proceedings of the American Electroplaters' Society, incorporating papers and discussions presented at Asbury Park.

The Educational Committee, headed by G. B. Hogaboom, should be congratulated on this work as it involved a change in printing with a judicious use of type variation. The printing of the volume enables a much greater amount of material to be encompassed in a smaller volume with a gain in readability.

The technical papers presented probably represent the most valuable collection of papers ever presented on electrodeposition at one technical session.

The improvement in the volume is in keeping with the continual progress of the technical aspects of the Society. It is our hope that future transactions will be able to follow the excellent example set by the 1939 volume of the Proceedings.

Magnesium Alloys

The technical developments on magnesium alloys and the adoption of these alloys by industry have been remarkable. The consumption of magnesium jumped from 600,000 lb. in 1930 to almost 5,000,000 lb. in 1938. Improved methods of refining and greater production volume have resulted in the price being reduced from $5.00 a lb. in 1913 to approximately 35c a lb. today.

Intensive research on the composition of alloys with high strength and special working properties has resulted in the development of cast alloys with excellent tensile strengths. These alloys contain about 6% aluminum with small amounts of zinc and manganese. Cast magnesium alloys are finding wide use in airplane construction, for example, for landing wheels and engine manifolds. Inasmuch as magnesium weighs less than one-fourth that of steel, the saving in weight markedly increases the pay load. Landing wheel castings as large as five feet in diameter have been made.

Magnesium die castings have been made during the past three years, with tensile strengths from 35,000 to 40,000 lb. per sq. in. High casting pressures up to 4,000 lb. per sq. in. are employed.

Magnesium alloys can be extruded, but due to their tendency to cold harden, the extrusions are made to size. Extrusion alloys contain 8.5% aluminum, 0.2% manganese, with small amount of zinc.

Magnesium alloys which can be rolled have been developed. The hot rolling is done at 800°F. and the final thickness is obtained by cold rolling.

Forgings are being made by press forging with tensile strengths from 45,000 to 50,000 lb. per sq. in. and heat treated forgings have been obtained with tensile strengths up to 60,000 lb. per sq. in.

Extensive work has been done on coatings to impart corrosion resistance especially salt water corrosion because of the use of magnesium alloys for airplane construction. Methods have been developed for electroplating magnesium and several methods are available for producing corrosion resistant films on the surfaces of the alloys. A method is available for producing films on magnesium alloys which can be dyed almost any color similar to the dyeing of aluminum oxide films.

The development and commercial usage, on a large scale, of magnesium alloys have resulted from extensive research similar to that done on zinc alloys and aluminum alloys.

The lightness of magnesium alloys together with their relative good physical properties should result in even more widespread use of these alloys.

New Supplement to Metal Industry

Starting with the present issue, a supplement entitled, "Organic Finishing", will appear in Metal Industry. This supplement will cover all phases of organic finishing, including, lacquering, enameling, japanning and painting.

It is intended that this supplement will cover the organic finishing field in the same technical manner as Metal Industry has covered the plating and finishing industry.

It is realized that many finishing superintendents have both organic and inorganic departments under their jurisdiction, and it is hoped, therefore, that the definite dividing of the technical information will facilitate the search for subject matter of particular interest.

The 21st Annual National Metal Congress and Exposition to Be Held in Chicago, Oct. 23-27

The 21st annual National Metal Congress and Exposition will be held in Chicago for five days beginning October 23rd. Optimism is high among more than 200 exhibitors and thousands of members of the four component societies meeting during the Congress.

Advance hotel and society reservations point to one of the heaviest enrollments in the history of the Congress. According to *W. H. Eisenman,* managing director of the Exposition and secretary of the sponsoring American Society for Metals, war in Europe has stimulated many additional exhibitors to sign for this year's space.

Complete exhibits of the Metal Congress will be held at the International Amphitheatre, Chicago. Society technical sessions will be held as follows:

A.S.M.—The Palmer House
Wire Assn.—Congress Hotel
A.I.M.M.E.—Blackstone Hotel
American Welding Society—Hotel Stevens

Last minute approvals from Chicago companies indicate that an unusually interesting route for plant visits has been arranged by A.S.M. officials.

Exterior view of International Amphitheatre, Chicago. Scene of 1939 National Metal Congress and Exposition.

Wire Association

The Wire Association will have 11 technical papers presented at its meetings with a plant visit scheduled to the Hawthorne Works of the Western Electric Company.

The American Society for Metals

The American Society for Metals will have over 50 technical papers presented on both ferrous and nonferrous metals and the treatment of metals.

The American Welding Society

The American Welding Society will hold its 20th annual meeting and at the technical sessions over 50 papers will be presented on applications of welding, research in welding, and various aspects of resistance and flame welding. In addition, cutting, flame hardening and hard surfacing will be discussed.

The American Institute of Mining and Metallurgical Engineers

The American Institute of Mining and Metallurgical Engineers will also hold technical sessions, at which 22 papers will be presented on physical metallurgical subjects.

Exhibitors at Metal Exposition

Advance Polishing Wheels, Inc., Chicago, Ill. Exhibiting buffs and buffing materials. Examples of how Perm-A-Core buffs may be used to reduce scrap loss, and buffing costs will be given. *Glenn Cannon* in attendance.

Alox Corporation, Niagara Falls, N. Y. Booth B-130.

Exhibiting: Ferrous and non-ferrous metal coated with special rust preventive compounds. Special corrosion prevention lubricating compounds will be displayed.

Chas. F. L'Hommedieu & Sons Co., Chicago, Ill. Exhibiting materials for the plating and finishing industry, including buffing and polishing wheels, compounds, the new variable speed lathes and equipment for the plating industry. *Arthur L'Hommedieu* in attendance.

Aluminum Company of America, Pittsburgh, Pa. Booth G-201.

Exhibiting (in operation): Display of the commercial forms of Alcoa aluminum alloys available, together with interesting examples of commercial applications of these alloys. Also, a similar exhibit of Mazlo magnesium and its alloys, including examples of commercial applications.

In addition the exhibit will include three features:

1. In a theater having a capacity

of between 40 and 50 seats, there will be a continuous showing throughout the hours of the exhibition of two motion pictures, one following the other. The first, entitled "Mine to Metal," shows all of the steps from extracting the ore to the final pouring of raw aluminum. The second, entitled "Fabricating Aluminum," shows all of the methods used commercially for machining and otherwise fabricating aluminum and its alloys.

2. The high speed cutting of Alcoa 11S-T3 alloy rod will be demonstrated continuously on an automatic screw machine, having a spindle speed of 6000 r.p.m. Stock ½ in. in dia. will be used, giving a surface speed of 785 ft. per minute. Souvenir buttons will be made at the rate of 18 pieces per minute.

3. The exhibit will also include the first public demonstration of furnace brazing of aluminum. This is a new development in the joining of aluminum, and is applicable to assemblies requiring high speed and relatively low-cost production.

Bausch & Lomb Optical Co., Rochester, N. Y. Booth D-119.

Exhibiting (in operation): Metallographic equipment, including the research equipment, conveniently arranged for bright field, dark field and polarized light illumination, the standard laboratory type of metallograph and the metallurgical microscope.

Large Littrow type quartz spectrograph, with numerous examples of its use in the analysis of metals, alloys and other industrial materials.

Greenough type Wide Field Binocular microscopes for the three-dimensional examination of materials, small fabricated parts, metal fractures, flaws, etc.

Shop and Brinell microscopes and other optical shop tools.

Large Littrow quartz spectrograph and accessories for the analysis of metals and alloys, with typical examples of its use.

Orthostereoscopic camera and Orthostereoscope for making and viewing three-dimensional photographs at various magnifications.

Binks Mfg. Co., Chicago, Ill. Booth C-137.

Exhibiting (in operation): A display of finishing units for all metal products: 1. An automatic reciprocating spray machine for flat ware. 2. An automatic rotary spindle type finishing machine for metal products of all sizes and shapes. 3. A dynaprecipitor spray booth with water wash action to clean spray fumes. 4. A complete line of standard spray guns and all accessories.

In attendance: J. F. Roche, president; J. F. Roche, Jr., vice president; S. Bramsen, vice president; E. F. Watts, advertising and sales promotion manager; H. Erickson, B. J. Hedger, F. L. Terrill, R. T. Hardy, J. E. Rowe, salesmen.

W. H. Eisenman
Secretary of American Society for Metals

The Bristol Co., Waterbury, Conn. Booth L-325.

Exhibiting (in operation): Control instruments and featuring proportioning pyrometer control—both air and electric as applied to heat treating temperatures. The instruments being exhibited include:

Pyromaster: a round-chart proportioning potentiometer controller with separable compact units, electrically connected and which are not in constant motion—in fact there is no motion at all until a change in temperature occurs. This instrument's unusual resistance to vibration will also be demonstrated.

Wide-Strip Pyrometer Controller, a strip-chart proportioning controller with dust-proof galvanometer precision—another feature of these instruments contributing to fine performance.

The Brown Instrument Co., Philadelphia, Pa. Booth D-123.

Exhibiting (in operation): Indicating, recording, controlling instruments and auxiliary equipment used in the production, fabrication and heat treatment of both ferrous and non-ferrous metals.

The exhibit will include a "Leaders of Industry" display listing 55 plants in which 3,391 Brown Potentiometer Pyrometers are measuring and controlling temperatures with laboratory accuracy.

Instruments for automatically controlling the temperature of electrically heated and oil or gas fired furnaces will be demonstrated. These will include electrically and pneumatically operated thermometers for die casting machines, ovens, tempering tanks and other services up to 1200 degrees Fahr.—also electrically and pneumatically operated control potentiometers for use with thermocouples or radiation pyrometers for hardening, brazing and annealing furnaces or other services up to 3400 degrees Fahr.

Crown Rheostat & Supply Co., Chicago, Ill. Booth L-329.

Exhibiting (in operation): Slow speed method of polishing. New style laminated cylinder. Rheostats. Centrifugal dryer.

In attendance: G. A. Spencer, president; G. E. Huenerfauth, vice president; L. J. Morper, secretary; Fred P. Green, W. G. Meggers, C. E. Clindinin, George Yochim.

The Dow Chemical Co., Midland, Mich. Booth M-302.

Exhibiting: Dowmetal magnesium alloys, such as sand castings; permanent mold castings; die castings; forgings; extruded shapes, bars, rods and tubes; and plate, sheet and strip.

The Electric Furnace Co., Salem, O. Booth I-202.

Exhibiting: Photographs of recent furnace installations and latest developments in special atmosphere equipment for copper brazing, scale-free heat treating, and bright annealing ferrous and non-ferrous products including wire, sheet, tubing, strip, stampings, bolts, and automotive parts, also samples of material treated in these furnaces.

Exhibit also includes photographs of outstanding electric, oil and gas fired furnaces built for normalizing, carburizing, short cycle malleableiz-

ing, nitriding, forging, enameling, annealing and other heat treating processes, also pictures of gas fired radiant tube furnaces, and Elfurno special atmosphere generators.

The Foxboro Co., Foxboro, Mass. Booth K-305.

Exhibiting (in operation): The new potentiometer recorder controllers. Also air-operated potentiometer controller, Stabilog potentiometer controller, Rotax temperature controller, indicating and recording gages, pickling tank control—air and electric operated valves.

Handy & Harman, New York. Booth E-107.

Exhibiting (in operation): A high speed production brazing job will feature exhibit—refrigerator valve parts will be joined with Easy-Flo Brazing Alloy and Handy Flux at high speed and low cost. The outstanding features of silver brazing alloys, Sil-Fos and Easy-Flo, will be emphasized on an illuminated background and by a large collection of samples. At another demonstration table the uses of these alloys in joining all sorts of metals will be carried on continuously. A separate show case will show silver clad metals and other forms in which silver is used in industry.

Charles Hardy, Inc., New York. Booth B-108.

Exhibiting (in operation): Metal powders and alloy powders. Products fabricated from metal powders including bearings, friction clutches, magnets, tool steels, stainless steels, gears.

Hardy-Lepel high frequency furnace lately developed for the sintering of metal powder products. This is the first time that such equipment has been demonstrated for powder metallurgical applications.

E. F. Houghton & Co., Philadelphia, Pa. Booth M-311.

Exhibiting (in operation): Liquid carburizing bath—operating with Perliton No. 45, a new Perliton development for faster penetration of carbon at short heat for production run of small parts.

A new non-burning carburizer—"Nu-Carb". A blackening salt—Houghto-Black. A new series of straight cutting oils and bases—Cut-Max—which will handle 90 per cent of all machining needs. A new alkaline cleaner for cleaning oil quenched work — "Houghto-Clean 145-S". A new lead pot covering and insulator for heads and risers of castings—Lapix.

Independent Pneumatic Tool Co., Chicago, Ill. Booth M-326.

Exhibiting (in operation): Thor portable electric drills, screw drivers, nut setters, hammers, sanders, polishers, grinders, saws, and tappers.

Leeds & Northrup Co., Philadelphia, Pa. Booth J-313.

Exhibiting (in operation): Various models of Micromax pyrometers, for use both with thermocouples and with Rayotubes. Exhibited for the first time is the new L&N optical pyrometer—a completely new instrument, not a redesign. Besides measuring directly in degrees, this instrument has many important features which increase accuracy of measurement and convenience of operation.

An outstanding demonstration of the micro-responsiveness of Micromax, with particular reference to its remarkable effect on automatic control.

Hardening and tempering furnaces and a unique demonstration of the various controls effected by the new Homocarb Carburizing Method.

P. R. Mallory & Co., Inc., Indianapolis, Ind Booth K-320.

Exhibiting: A complete exhibit of parts made from Mallory non-ferrous alloys, including all sizes and types of spot welding tips, seam welding wheels, flash, butt, and projection welding dies, water cooled holders, and many miscellaneous products, such as flat springs, backings, bushings and bearings.

Also a complete showing of Mallory electrical contacts of tungsten, silver, molybdenum, Elkonite, and special alloys for every type of service. Circuit breakers and other apparatus showing Mallory contacts in use will be featured.

New products on display will include universal offset and ejector types of water-cooled holders for spot welding tips, and a new tip dresser.

The Pyrometer Instrument Co., New York. Booth J-331.

Exhibiting (in operation) "PYRO" optical pyrometers; bi-optical pyrometers; micro-optical pyrometers; remote-optical pyrometers; radiation pyrometers; immersion pyrometers; surface pyrometers; and radiation tubes.

Standard Steel Spring Co., Coraopolis, Pa. Booth L-314.

Exhibiting (in operation): The exhibit will be devoted to the new corrosion proof coating "Corronite", a pore-free metallic coating. Samples of the coating as applied to welded electro-metallic tubing, skelp, a sucker rod, and a steel barrel will be on display.

An operating exhibit will show the "Corronite" coating under test in aerated solutions in comparison with other metallic coatings.

C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. Booth K-335.

Exhibiting (in operation): Among the many interesting instrument developments on display at the Tag Booth will be found: Potentiometer Pyrometers; Model V Vibration-proof Indicating Controller; Self-Balancing Indicating Controller; Self-Balancing Indicator with "In Balance" Signal; Recorder-Controller for Throttling Fuel Heat; Recorder-Controller for Throttling Electric Heat; Two-Point Indicating Controller; Multiple Point (up to 6) Indicating Controller; and Cabinet Type Indicator.

In addition to these Celectray Pyrometers and Resistance Thermometers, Tag Air-Operated Indicating and Recording Controllers, Tag Industrial Thermometers will be on display.

Wheelco Instruments Co., Chicago, Ill. Booth J-332.

Exhibiting (in operation): New Potentiometer Controller which has only recently been announced. This combines the sensitivity of the Wheelco "Radio Principle" control with the accuracy of the potentiometric method of temperature measurement.

The new Thermometer Recording Controller will also be exhibited.

Wilson Mechanical Instrument Co., Inc., New York. Booth H-207.

Exhibiting (in operation): "Rockwell" hardness tester. "Rockwell" superficial hardness tester. "Rockwell" motorized hardness tester. Special "Rockwell" testers for internal testing. Work support accessories for "Rockwell" hardness tester.

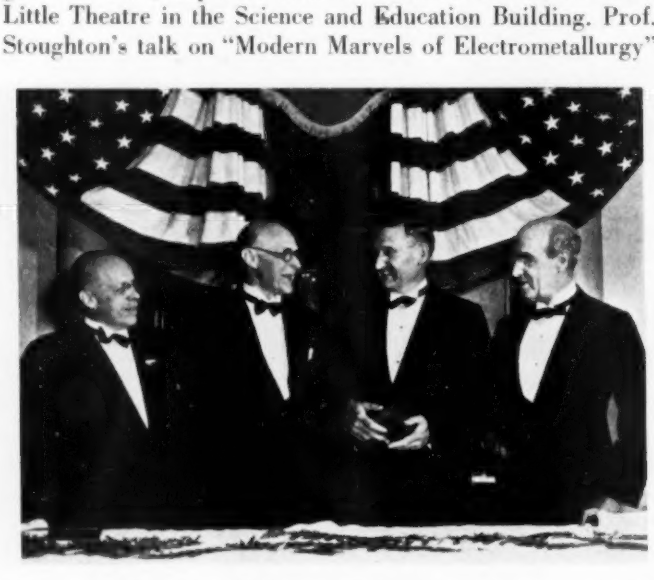
New York Meeting of the Electrochemical Society a Success

The 76th meeting of the Electrochemical Society was held at the Commodore Hotel in New York City, September 10-13. A total of 222 persons registered with 27 women in attendance.

The Monday morning session on "Recent Progress in Electro-Analysis" was presided over by *Prof. Hiram S. Lukens* of the University of Pennsylvania. Nine papers were presented at this session.

Monday afternoon was spent at the World's Fair, where the members attended a demonstration in the "House of Magic" of the General Electric Company, and were also given a showing of man-made lightning in the Steinmetz Hall of the General Electric Co.

At 5 P.M., *Prof. Bradley Stoughton* of Lehigh University gave the 6th Joseph W. Richards Memorial Lecture in the Little Theatre in the Science and Education Building. Prof. Stoughton's talk on "Modern Marvels of Electrometallurgy" was well attended by both members and the general public.



Four of the five living scientists who have won the Acheson medal, highest award for scientific achievement bestowed by the Electrochemical Society, are here grouped in one picture. Three were congratulating Dr. Francis C. Frary (holding medal), director of Aluminum Company of America research laboratories and newest winner, at a meeting of the society in New York. Left to right: Dr. Colin G. Fink, Dr. Frank J. Tone, Dr. Frary and Dr. Frederick M. Beckett. Dr. Frary, honored for his work in developing important aluminum alloys, donated the $1,000 cash prize which goes with the medal to establish a fund for workers in his laboratories to further their technical education.

A dinner meeting was held at the Fair in the Cafe Turf Trylon and the balance of the evening was spent in viewing the Fair.

The Tuesday morning technical session on "Influence of Cathodic Reactions on Corrosion" was presided over by *Dr. Robert B. Mears* of the Aluminum Company of America. Twelve papers on various aspects of corrosion were written by authors from England, Poland, Sweden, Germany and the United States. Among these authors were *T. P. Hoar* of Cambridge University, England; *W. J. Mueller*, Germany; *U. R. Evans* of Cambridge, and *H. E. Haring* of the Bell Telephone Laboratories of N. J.

The noon, round-table luncheon was featured by a very interesting talk by *A. W. Winston* of the Dow Chemical Company, Midland, Mich., who spoke on "Modern Magnesium." A lengthy discussion followed Mr. Winston's talk.

The afternoon was spent in plant visits which included a visit to the plating department of the American Safety Razor Co., Brooklyn, N. Y., led by *Dr. Charles A. Marlies;* to Philip Sievering, Inc., led by *Ralph McCahan* of duPont, and to the Westinghouse Lamp Division, Bloomfield, led by *Dr. W. R. Meyer* of Metal Industry.

At the dinner on Tuesday evening, *Dr. Francis C. Frary* of the Aluminum Company of America, was presented the Acheson medal and a $1,000 prize. "Electrochemical Recollections" was the topic of Dr. Frary's speech of acceptance.

Dancing followed until the early hours of the morning.

The final scientific-educational session, held on Wednesday morning was under the auspices of the Electrodeposition Division at which *Dr. Raymond R. Rogers* of Columbia University, presided. Seven papers were presented.

Abstracts of Papers Presented
Recent Progress in Electro-Analysis

Electrotitrations. By N. Howell Furman.

This review atempts to point out the more significant lines of progress in the fields of potentiometric titrations, conductometric titrations and polarographic titrations in the period 1931-1939; only a portion of the hundreds of papers that have appeared is cited to illustrate particular trends.

Internal Electrolysis as a Method of Analysis. By Beverly L. Clarke and L. A. Wooten.

Internal electrolysis as applied to electro-analysis dis-

penses with an external e.m.f. The idea originated with Ullgren in 1868 and his simple apparatus comprised a zinc anode connected to a platinum dish serving as cathode. In recent years improved methods of internal electrolysis have been developed. The authors' apparatus comprises the use of a lead or aluminum anode and a platinum gauze cathode. Accurate determinations of copper and cadmium in zinc base alloys, and of tin in aluminum base alloys are readily carried out. The method affords an automatic means of controlling the cathode potential. The method is particularly applicable to the separation of impurities from the bulk of a base metal.

A Pulse Amplifier for Performing Differential Electrometric Titrations. By Henry H. Baker, Jr., and Ralph H. Mueller.

A pulse amplifier is developed for performing differential electrometric titrations directly. In contradistinction to former methods in which this is achieved by the mechanical isolation of a portion of the solution around one electrode, a pulse amplifier is used which responds only to *changes* in potential. The circuit used permits observations by the new method, with a constant check of the results by the conventional technique, inasmuch as the first stage represents a simple vacuum tube voltmeter. The results are entirely independent of rate of stirring above a moderate minimum value. The rate of attainment of equilibrium is a vital factor, but in most cases it is sufficiently rapid for the new technique. In a well known case, oxalate-ceric, in which equilibrium is reached slowly, the familiar use of iodine chloride as a catalyst eliminates the difficulty. The validity of the pulse method for differential titration is demonstrated with seven representative examples of potentiometric titration of the acid-base, oxidation-reduction, and precipitation types. The precision is of the order of 0.1 per cent and the measurements reveal no fundamental objection to the use of a more precise volumetric technique employing weight burettes or more dilute reagents.

The Detection of Small Traces of Copper Using the Antimony Electrode. By G. A. Perley.

An electrochemical colorimetric method of testing for small traces of copper ions, 0.1 p.p.m. to 0.5 p.p.m., is described and this has been found useful in establishing the proper location of recording antimony electrode assemblies. It has made possible the use of this electrode where it would otherwise have been unsatisfactory. The pH range is 2 to 8. The Sb electrode is introduced into the solution to be tested for copper. The trace of copper present is precipitated on the Sb by displacement. The copper-coated end of the electrode is then placed on a filter paper supported on a nickel plate (cathode) and wetted with 2 drops of a 25 per cent solution of $NaNO_3$ plus 1 drop of a 0.1 per cent solution of diethyldithiocarbamate. A current of 20 milliamp. is applied, copper goes into solution, producing a brown stain on the filter paper which is compared with a set of standards.

Measurements With the Dropping Mercury Electrode. By G. A. Perley.

A brief outline of the dropping mercury electrode method of analysis is presented. The recording and non-recording types of equipment for the current-voltage curves of a mercury electrode have their own fields of usefulness. It is suggested that many of the advantages which are claimed for the method must be qualified. The more important limitations of the method are noted. The majority of the limitations of the method are involved with the phenomena which occur at the dropping mercury electrode. The technique of the method is such that considerable experience is desirable if the greatest value is to result from the use of the method. The value of the method to the analytical laboratory depends upon the willingness of the research staff to standardize methods for the variables which may be encountered in the specific applications.

Polarization and Overvoltage With Special Attention Given to Transfer Resistance. By A. L. Ferguson.

A brief review of a series of researches that has been in progress in the author's laboratory for about fifteen years. The object has been primarily to study the two general methods for measuring polarization and overvoltage known as the direct and commutator methods. Attention was focused largely upon an explanation commonly given for the observations that the direct method gives larger values than the commutator. In the course of the investigations it was shown that the commutator possesses several inherent sources of error which cause it to give highly misleading information. It was shown that the direct method can be relied upon to give true overvoltages. Strong evidence is produced against the existence of such a phenomenon as transfer resistance. Total overvoltage appears to consist of at least two components, one that drops vary rapidly with time and another that drops much slower; the former component is the only one that changes appreciably with current density.

A New Theory of Overvoltage. By H. Eyring, S. Glasstone and K. J. Laidler.

A theory of overvoltage of a novel type has been developed from considerations based on the theory of absolute reaction rates. It is suggested that in an aqueous solution a layer of water molecules becomes attached to the electrode and a corresponding, adjacent, layer is associated with the solvent. The slow process, which is the fundamental cause of overvoltage, is believed to be the transfer of a proton from a molecule of water attached to the solvent to one on the electrode surface. It is shown that the connection between the overvoltages of various metals and their physical and chemical properties is in harmony with the theory. Oxygen overvoltage is attributed to the slow rate of transfer of protons in the opposite direction, thus accounting for some striking similarities between anodic and cathodic polarization. The views developed here show why appreciable overvoltages accompany the liberation of oxygen and hydrogen from aqueous solution, but are not observed in the discharge of chlorine ions.

The Study of Cathodic Reactions in Metallic Corrosion. By T. P. Hoar.

The importance of the study of cathodic reactions under conditions similar to those of natural corrosion is pointed out, and the danger of extrapolating results obtained at higher current densities to those obtaining in corroding systems is stressed. The mechanisms of the hydrogen-evolution and oxygen-dissolution cathodic reactions are discussed, especially in relation to "hydride" and oxide films and (in the case of iron) the diffusion of cathodic hydrogen through the metal. The influences of inhibitors, and of accelerators of the "depolarizer" type, are briefly considered.

Papers on Corrosion

The Influence of Cathodic Reactions on the Corrosion of Metals From the Viewpoint of the Local Current Theory. By W. J. Mueller.

Tests on galvanized steel pipe were conducted which showed that the zinc in the coating behaved as cathode when submerged in hot tap water. This cathodic behavior of zinc could, in general, be definitely established only at temperatures above about 70° C. The experimental results tend to clarify a number of apparently unusual corrosion phenomena observed in practice with galvanized pipe used in hot water service.

Observations on the Behavior of Steel Corroding Under Cathodic Control in Soils. By I. A. Denison and R. B. Darnielle.

Observations and measurements were made on the behavior of steel corroding under cathodic control in a wide variety of soils. The criterion for cathodic control was the relatively slight change in the potential of the anode produced by increasing the current density, as compared with the potential change of the cathode. The more positive open-circuit potentials assumed by the cathode with time, indicated that the potential of the cathode tended to approach the potential of the oxygen electrode for the particular environment. Approximately linear correlations between the loss of weight of the anodes of the corrosion cell, the maximum short-circuit current developed by the cell and the current at the corrosion potential suggested a possible electrical method for measuring the corrosiveness of soils. The development of corrosion products in soils was observed through glass in specially designed corrosion cells. The most characteristic development in the soils studied was the formation of a dense membrane of iron oxide between the anode and the cathode. A probable relation between membrane formation and rate of corrosion is suggested.

The Nature of the Cathode in the Rusting of Iron. By Sven Brennert.

The earlier conception of the rusting of iron was that the impurities in the surface of commercial iron, such as graphite and carbide, act as cathode areas. Later, however, it was suggested that the cathode area was an oxide film. According to the earlier theory, there is the possibility of producing a rustless steel by removing the graphite and other impurities out of the surface. According to the later theory, however, such a procedure is doomed to fail. In the present investigation a special case was studied, namely, the corrosion of iron in a streaming, aerated sodium chloride solution. It was found that the impurities do not, at least in this case, have any noticeable cathodic properties and that an oxide film on the surface of the iron is the active cathode area.

Electrochemical Studies of the Corrosion of Steel and Magnesium in Partly Inhibited Solutions. By L. J. Benson, R. H. Brown and R. B. Mears.

The self-generated current method of examining the anode and cathode reactions which has been previously employed to studies of the corrosion of stainless steel and aluminum has been applied to ordinary low carbon steel and magnesium in partly inhibited salt solutions. It was found that in neutral chloride solutions partially inhibited with potassium carbonate, the corrosion of steel is largely under anodic control. Similarly, in neutral chloride solutions partially inhibited with sodium fluoride, the corrosion of magnesium is largely under anodic control. It was also found that in the latter solution an increase in the fluoride content increases the potential difference between the local elements on the magnesium, so that in order for the fluoride to function as an inhibitor it must increase the polarization at the electrodes more rapidly than it increases this difference in potential.

Rate of Solution of Zinc and Aluminum While Cathodic. By B. P. Caldwell and V. J. Albano.

The phenomenon of cathodic protection was investigated from the kinetic standpoint in an attempt to obtain an understanding of the factors controlling the process. The corrosion by acid of a zinc cathode at various current densities was investigated by time-rate, and temperature coefficient studies. In addition, a study was made of the corrosion of aluminum while cathodic in acid, in neutral, and in alkaline electrolytes, and the effect of agitation on the corrosion under these circumstances was determined. The results indicate that the nature and thickness of the film of solution immediately adjacent to the cathode determine the extent of corrosion of the metal while cathodic. Aluminum undergoes corrosion instead of protection when made cathodic in sodium sulfate solution. However, in sodium hydroxide solution its normal rate of corrosion is not altered as a result of making it cathodic.

An Electrochemical Study of the Corrosion of Painted Iron. By H. E. Haring and R. B. Gibney.

The corrosion protective value of approximately 50 different paints was determined by means of an electrochemical method which has been previously described. This determination involved the measurement of the change in the potential of the painted iron with time when wet with water for 24 hr. or less. It was found that the interpretation of the time-potential curves which were automatically plotted by a recording vacuum tube electrometer, was facilitated if the test was conducted in a nitrogen atmosphere. The results obtained with the electrochemical or potentiometric method compared favorably with those obtained in a one-year outdoor exposure test. Such differences as were found were shown to be due either to deterioration or improvement in the paint film as the result of weathering.

The Classification of Anodic and Cathodic Inhibitors. By E. Chyzewski and U. R. Evans.

Experiments in a divided cell were carried out to distinguish anodic from cathodic inhibitors—a matter of practical importance since anodic inhibitors, if added in insufficient quantity, may actually intensify attack. The cell contained iron and copper electrodes when testing for an anodic inhibitor, and iron and zinc electrodes when testing for a cathodic inhibitor, the solution usually being potassium sulfate. A drop in the current when the substance under test was introduced into the iron compartment indicated an inhibitor, and an increase of current a stimulator; the matter was further verified by noting the movement of the potentials. Sodium hydroxide and carbonate were found to act as both anodic and cathodic inhibitors, zinc sulfate as cathodic inhibitor only, and

emulsifying oil as an anodic inhibitor. In presence of alkali, a chromate inhibits the cathodic reaction, but in presence of acid, there is marked stimulation at the cathode; chromates act as anodic inhibitors in neutral, but not in acid, solutions. Magnesium sulfate is a cathodic stimulator. Various organic inhibitors were also studied.

Tarnish Studies. By W. E. Campbell and U. B. Thomas.

A method is described for analysis of tarnish films on metals by electrolytic reduction at the cathode. Its suitability is demonstrated for the rapid and accurate measurement of oxide films on copper varying in average thickness from monomolecular layers to 1,000 Å. It is shown to be useful for reduction of mixed oxide-sulfide films on copper and silver. The method is used to measure the oxide films on freshly reduced copper after one-half hour's exposure to oxygen or air. Such films are shown to be 10-20 Å thick. A thicker film, measuring 30-70Å is found to be produced by abrasion of copper in air, water, benzene or toluene. Adaptations and modifications are discussed which give wide analytical application to the method.

The Electrometric Estimation of the Tarnish Products on Silver and Copper Alloys. By L. E. Price and G. J. Thomas.

The determination of the character and composition of corrosion products is not a simple matter. When the corrosion products upon a surface are insoluble in water and are reducible at potentials more positive than that at which hydrogen is evolved, the electrometric or polarographic method forms a convenient and rapid way of estimating the corrosion products even when the total amount of corrosion corresponds to a film not more than a hundred angstroms thick. The method has been applied by the authors to the estimation of corrosion products on silver and its alloys containing silver sulfate (which was estimated as silver chloride), silver sulfide, cuprous oxide, and cuprous sulfide, and has been of especial use in detecting and estimating the slight traces of silver sulfide formed on silver when protected by the electrodeposited films of beryllia described in a previous paper.

The Formation of Hydrogen Peroxide During Corrosion Reactions. By J. R. Churchill.

Hydrogen peroxide was shown to be formed during the corrosion of aluminum and other metals in the presence of an excess of oxygen. The Russell effect of metals was found to be caused by the production of hydrogen peroxide and to provide a highly sensitive test for the formation of hydrogen peroxide at metal surfaces. The reaction by which hydrogen peroxide is formed during corrosion was found to be essentially cathodic and appeared to involve the oxidation of atomic hydrogen by molecular oxygen.

Papers on Electrodeposition

The Electrodeposition of Lead From Solutions of Lead Sulfamate With Addition Agents. By Frank C. Mathers and Robert B. Forney.

The effects of a number of addition agents on cathode deposits of lead from solutions of lead sulfamate containing free sulfamic acid were determined. Combinations of addition agents containing aloin, resorcinol, glue, pyrogallol, B-naphthol, casein, malic acid, cresylic acid, furfural, and goulac produced the best deposits which were smooth, finely crystalline and tough.

Porosity of Electrodeposited Silver on Steel. By Frank C. Mathers and Lyle I. Gilbertson.

The porosity of electrodeposited silver on steel is dependent on the thickness of the plate, the roughness of the basis metal, and the method of applying the silver plate. Brush plating results in greater protection with thinner plate at a sacrifice of adherence. The use of a silver strike does not affect the porosity of brush plated silver on steel. Bath plated steel with 0.0016-0.0040 in. (0.04-0.10 mm.) of silver should be suitable for use in the fabrication of industrial vessels. Brush plated steel with 0.0001-0.0002 in. (0.0025-0.005 mm.) of silver should be suitable for containers of a temporary nature where great mechanical adherence is not required.

The Rate of Decomposition of Hydrogen Peroxide in Nickel Sulfate Plating Baths. By Gerald U. Greene.

Previous observations on the causes of the decomposition of hydrogen peroxide in the presence of metal salts are briefly reviewed. Experiments of the author indicate that nickel hydroxide causes very rapid decomposition of the peroxide. Upon adding H_2O_2 in increasing quantities to a clear nickel sulfate bath, the rates of decomposition of the H_2O_2 remained practically constant. But increasing the pH of the bath increased the decomposition rate. Likewise, increasing the temperature of the bath increased the rate.

Anodes for the Electrowinning of Manganese. By Colin G. Fink and Morris Kolodney.

Manganese is a metal of great importance in the manufacture of steel. Domestic ore deposits are unsuitable for thermal reduction, but may be used in electrowinning from sulfate leach solutions. Lead anodes are unsatisfactory in these solutions because they cause a loss of manganese by oxidation to manganese dioxide. Duriron anodes were investigated but proved to be undesirable. An alloy anode of lead, tin and cobalt was developed which operates satisfactorily, and whose use would result in decreasing the cost of electrowinning manganese. A theory of the oxidation of manganous ion by lead peroxide at lead anodes was evolved.

Electrolytic Preparation of Sodium Arsenate. By Leo Lowenstein.

The electrolytic oxidation of sodium arsenite to sodium arsenate has been investigated before but apparently no commercial progress is in operation today. This is attributed to high cost of operating the cell and, specifically, to the relatively low current efficiency. Unless proper precautions are taken, the product is badly contaminated with unoxidized arsenite. The Lloyd and Kennedy process for sodium arsenate is analyzed to determine the cause of the low efficiency. Experiments result in a new 98 per cent efficient diaphragm cell operating at 2.2 v. with electrolyte temperature at 70° C., the anolyte in constant circulation through a crystallizing tank (20° C.) in which sodium arsenate separates out; the return of the mother liquor into the anode compartment of the cell; and, finally, the addition to the anolyte of 1.6 per cent sodium bichromate, which remains in the anolyte almost indefinitely.

Plating on Lead-Antimony Alloys

By Lionel Cinamon, Ch. E. and Eugene Epstein, Ch. E.

Special Chemicals Corp.,
New York, N. Y.

The authors describe the results of a long series of tests on sequences for silver plating on lead-antimony alloys. It was found that sodium laurate in an alkaline cleaner may form films on the alloys which lead to blistering of the silver. Methods are given for removing the deleterious films formed by the use of laurates.—Ed.

A problem of properly plating lead-antimony handles with a copper, zinc, tin alloy† underplate prior to silver plating on copper trays having also a white metal trim was presented to us. This apparently difficult problem was presented to us by a large firm which experienced difficulty in handling this combination of metals. The lead handles, when plated, peeled and blistered upon burnishing.

The plating cycle attempted by the plant was as follows:

Procedure

a. First Cleaner—3 oz./gal. at 180° F. Soak 2 minutes and swab.

b. Second Cleaner — electrolytic; 8 oz./gal. at 180° F.—Cathodic treatment 1 minute.

c. Hydrochloric Acid (14%) Dip.

d. Cyanide Dip—NaCN—4 oz./gal.

e. Alloy Plate—4 minutes at 4½ volts. Temp.—150° F.
 Free cyanide .... 2.5 oz./gal.

f. First Silver Strike—15 seconds at 30 amps./ft.².
 Silver .... ½ oz./gal.
 Free cyanide .... 10 "
 Potassium carbonate . 4 "

g. Second Silver Strike—15 seconds at 20 amps./ft.². Temp. 30° F.
 Silver .... ¾ oz./gal.
 Free cyanide .... 8 "
 Potassium carbonate . 4 "

h. Final Silver Plate—15 minutes at 5 amps./ft.². Temp. 80° F.
 Silver .... ¾ oz./gal.
 Free cyanide ..... 4½ "
 Potassium carbonate 6 "

† Commercially known as "Spekwite."

These procedures and formulae were duplicated in our laboratory with the exception of the first and second cleaners. Using the above described procedure with solutions made up in our laboratory to their formulae, no blistering before or after burnishing was experienced. The procedure was varied in many ways, using laboratory solutions, in order to study the effects of these variations.

Lionel Cinamon

(Note: * denotes variations from above standard solutions or procedures.)

I.

a. First soak cleaner—2 minutes and swab.
*b. Hydrochloric acid dip.
*c. Second electrolytic cleaner—cathodic treatment 1 minute.
d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
 Results ...... No blistering.

II.

a. First soak cleaner—2 minutes and swab.
b. Second electrolytic cleaner—cathodic treatment 1 minute.
*c. Nitric acid dip—3%.
d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
 Results ...... No blistering.

III.

a. First soak cleaner—2 minutes and swab.
*b. Second electrolytic cleaner — 8 oz./gal.—at 180° F. Used anodically.
c. Hydrochloric acid dip.
d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
 Results ...... No blistering.

IV.

a. First soak cleaner—2 minutes and swab.
b. Second electrolytic cleaner—cathodic treatment 1 minute.
c. Hydrochloric acid dip.
*d. Hot cyanide—NaCN—4 oz./gal.—electrolyze cathodically for 4 seconds.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
 Results ..... No blistering.

V.

a. First soak cleaner—2 minutes and swab.
b. Second electrolytic cleaner—cathodic treatment 1 minute.
c. Hydrochloric acid dip.

*d. Hot cyanide—NaCN—4 oz./gal.—electrolyze anodically for 4 seconds at 5 volts. Temp. 120° F.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
Results ...... No blistering.

VI.

a. First soak cleaner—2 minutes and swab.
*b. Hot copper strike 140°-180° F. 1 to 2 minutes at 6 volts.

Copper cyanide	1	oz./gal.
Sodium cyanide	2	"
Sodium hydroxide	4	"
Trisodium phosphate	2	"

c. Hydrochloric acid dip.
d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
Results ...... No blistering.

VII.

a. First soak cleaner—2 minutes and swab.
b. Second cleaner — cathodic treatment 1 minute.
*c. Arsenic dip

Arsenic trioxide	60 gms.
Hydrochloric acid con.	1 liter

d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
Results ...... No blistering.

VIII.

a. First soak cleaner—2 minutes and swab.
b. Second cleaner — cathodic treatment 1 minute.
*c. Hot sodium hydroxide dip at 150° F.
Caustic soda ...... 2 oz./gal.
d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
Results ...... No blistering.

The above-mentioned variations produced fine, adherent plates and blistering was produced only in the following procedures:

IX.

a. First soak cleaner—2 minutes and swab.
b. Second electrolytic cleaner—cathodic treatment 1 minute.
*c. No acid dip.
d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.

Results—Blistering was very evident and we noticed that the cyanide failed to clean the lead handles.

X.

a. First soak cleaner—2 minutes and swab.
*b. Second electrolytic cleaner — 8 oz./gal.—anodically at 180° F.
*c. Nitric acid dip—3%.
d. Cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
Results .... Blistering.

The nitric acid in the above procedure was not sufficient to clean the black smut produced on the handle.

Since smooth adherent plates were obtained by duplication of the other firm's formulae and procedures; and by changing their procedure, blistering was observed in only two out of ten variations; we were led to believe that contamination of the plating solutions at the plant might be the fault. Samples of each solution as taken from the actual tanks in the plant used in the various plates and dips were obtained. The use of these solutions and the plant's standard procedure produced blisters.

It was then up to us to determine which solution was at fault. Since perfect plates with our duplicate laboratory solutions were obtained, it was believed that by a careful process of substitution, the faulty solution could be determined. Since silver plating is an old art and not very likely to cause the trouble, we decided to check from the alloy plate back. We started substituting our laboratory solutions in the reverse order of the plating procedure which turned out to be the long way around.

(Note: In the following procedures the solutions are those used at the plant except where specific notations denote our laboratory solution.)

A clue was obtained by observing that a plate free from blistering could be produced only by substituting our first cleaner for the first cleaner that had been used at the plant. Tests thus far indicated that the first cleaner used by the plant was causing the trouble. It was decided to check these assumptions by using our laboratory solutions in the standard procedure and substituting the plant's solutions one by one. If these assumptions were correct, the only time when blistering should be produced would be when we substituted the plant's first cleaner for our laboratory cleaner.

We, therefore, used the following cycle with the soak and electrolytic cleaner as noted below; they being the same as used throughout our work.

XI.

a. First cleaner at 180° F. Soak 2 minutes and swab. A 3 oz./gal. concentration of an alkaline cleaner† containing rosin was used.
b. Second cleaner (electrolytic) — Cathodic treatment 1 minute at 180° F.; an 8 oz./gal. concentration of a rosin-alkaline cleaner‡ was used.
c. Hydrochloric acid dip.
d. Sodium cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.
Results ...... No blistering.

Substituting the plant's first soak cleaner in the above procedure gave us blistering. This checked our suspicions noted previously and definitely located the cause of the blistering to be the first cleaner that was used at the plant.

This immediately opened up several lines of thought and investigation, namely: why should one cleaner cause blistering and another not? Is it possible to use any type of cleaner by varying the procedure or introducing various dips? A further *intensive* inquiry at the plant as to the composition of the first cleaner revealed that it was not a standard cleaner but contained a lauryl sulphate. This is a problem that troubleshooters sometimes run into when they seek to overcome difficulties because the exact composition of a particular solution, which may be causing trouble, is withheld from investigators. Only after a long process are they able to locate the difficulty which otherwise might have been a simple problem.

Now knowing that the cleaner used at the plant was found to be an entirely different type than was used in normal plating procedure, they also remembered that when silver had been

†Special Chemicals Corp's. "Spekleen No. 10".
‡Special Chemicals Corp's. "Spekleen No. 26".

plated directly on the lead-antimony alloy they had observed, that in the first silver strike, a black material seemed to "walk off" the work. This gave us another clue. Checking the process and looking at the combination of the solutions used, we could see that the first and second silver strikes were high cyanide solutions with very little silver content. They were indeed acting not only as a silver strike but as an electrolytic cyanide cleaner, which was able to remove any insoluble compound from the work that was somehow being formed by the use of the first cleaner.

In looking over the results obtained thus far, we now can see a reason why in plating the white copper, zinc, tin alloy, blistering occurred. We immediately plated the white metal with the ternary alloy underplate only after a brief hydrochloric acid dip and a mild cyanide rinse which was not sufficient by a dip action alone to remove any soap or metal compound which might be formed in the first cleaning operation. In the plating of silver directly on lead, we went through two longer strikes which by electrolytic action removed the compound causing trouble.

The cleaner which we used contained a metasilicate and some rosin. This cleaner was entirely soluble and does not form any insoluble compound with the lead base articles. However, at the plant the lauryl sulphate had been used in the first cleaner, and formed insoluble lead compounds—lead laurate and lead sulphate. The solubility of lead laurate at 35° C. is 0.09 grams in a liter of water, while that of lead sulphate is 0.056 grams per liter of water at 40° C. Both are, therefore, highly insoluble. The use of a hydrochloric acid dip only further increased the trouble, tending "to freeze on" the insoluble matter, because, as is well known, hydrochloric acid will precipitate insoluble soap from a soap solution. This is exactly what happened. The laurate cleaner had been forming the lead laurate soap and lead sulphate, which was then precipitated by the hydrochloric acid dip.

Using the above theory, we set about to overcome the difficulty and we succeeded in doing this with but slight variation in the procedure that used the laurate soap soak. Some of the procedures that gave us good results were:

XII.

a. First cleaner (laurate) — soak 2 minutes and swab.
b. Second electrolytic cleaner—cathodic treatment 1 minute.
*c. Sodium cyanide—NaCN 4 oz./gal. —electrolyze anodically for 15 seconds at 5 volts. Temp. 150° F.
d. No hydrochloric acid dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.

In the above procedure, several things may be noted: (1) the elimination of the hydrochloric dip and the use of a reversal of current, (2) the treatment of the work cathodically in a non-soap cleaner. Immediate reversal of the current in a cyanide solution was sufficient to remove any insoluble metal compound which had formed after the first cleaner.

Another successful variation was:

XIII.

a. First (laurate) cleaner—soak 2 minutes and swab.
b. Second electrolytic cleaner—cathodic treatment 1 minute.
*c. Nitric acid dip—8%.
d. Sodium cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.

In the above procedure, we substituted the strong nitric acid dip for the hydrochloric acid dip on the theory that nitric acid would dissolve the lead soap. The use of nitric acid is objectionable in cases where the copper is plated in conjunction with lead handles. The nitric acid etches copper slightly.

Still another successful variation was:

XIV.

a. First cleaner (laurate) — soak 2 minutes and swab.
*b. Cyanide dip—NaCN—4 oz./gal.—15 seconds.
*c. Second electrolytic cleaner—cathodic treatment 1 minute.
d. Cyanide dip—30 seconds.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.

Results ...... No blistering.

A procedure that had been recommended by Dr. Walter Meyer in The Monthly Review of the American Electroplaters' Society of March, 1936, was also used and gave good results.

Dr. Meyer's procedure recommended for nickel plate on lead-antimony alloys is:

XV.

1. Solvent or vapor clean.
2. Electrolytic clean cathodically 1-3 minutes.
3. Reverse clean (work the anode)—15 seconds in 4 oz./gal. sodium carbonate.
4. Dip in caustic soda at 150° F.
   Caustic soda ...... 2 oz./gal.
5. Hydrochloric acid dip—20%.
   Proceed to plating.

We varied the procedure of number XV to conform with our particular problem and used the following cycle:

XVI.

a. First cleaner (laurate) — soak 2 minutes and swab.
*b. Sodium hydroxide dip—150° F.
   NaOH .... 4 oz./gal.
c. Electrolytic cleaner — cathodically 1 minute.
d. Sodium cyanide dip.
e. Alloy plate—4 minutes.
f. First silver strike—15 seconds.
g. Second silver strike—15 seconds.
h. Final silver plate—15 minutes.

The above described procedures using the laurate cleaner gave us good plates free from blistering when we introduced caustic, nitric acid and cyanide dips which dissolved any insoluble lead compound. Electrolytic treatment which would remove the metallic soap compound formed also is satisfactory.

We can now conclude that in plating lead, the cleaning operation is of paramount importance and a cleaner should be avoided which will form an insoluble compound with the lead. A cleaner that does not attack lead should be used, or one that forms a soluble lead compound. If good cleaning and degreasing action is desired, and the laurates are efficient in this respect, the lead compound which is formed must be removed by some of the methods suggested above, namely a reversal of current, which in its anodic action, would dissolve any foreign metal compound; or by introduction of a dip after the formation of the insoluble metal soap which would dissolve or render soluble the lead compound formed.

Electroforming with Iron*

The authors describe the Ekko[1] process for producing molds and dies by the electroforming of iron. By this process, molds may be duplicated economically of a wide variety of objects such as jewelry, ceramic objects, metal castings or stampings with remarkable reproduction of fine detail. Molds or embossing plates to reproduce natural surfaces such as leather grains, can be readily made. Photographic likenesses in metal can be readily reproduced and dies and punches for metal stamping are easily made. The process seems to have many possibilities. —Ed.

By A. W. Bull, J. W. Bishop, M. H. Orbaugh, and E. H. Wallace

United States Rubber Co., Detroit, Mich.

Introduction

Electroplating is usually employed for the purpose of adding a thin layer of metal to surfaces to improve their appearance or to increase the resistance of the underlying material to corrosion or abrasion. In some cases, the plating is prolonged to obtain a relatively thick layer of plated metal, which is later separated from the surface against which it has been plated. In describing such treatment, the term "electroforming" is more suitable than "electroplating." One commercial application of electroforming is the preparation of electrotypes or printing plates by electroforming copper on wax impressions of type.

Electroforming in copper has also been applied to the preparation of some types of molds. However, most mold requirements are too severe to permit the use of copper and one of the stronger metals, such as iron, is required.

Electrodeposition of iron has been described in numerous publications and various commercial applications have been made, particularly to special iron for transformer cores or for the repair of worn machine parts. Printing plates have also been made from electrodeposited iron. Apparently, however, the usual iron solutions have proved unsatisfactory, so the process has had only limited application.

Figure 1 (top) shows steps in making tire molds. Figure 2 (middle) shows how electroplated iron molds may be backed by casting aluminum around them. Figure 3 (bottom) shows production of mold from the object (radio dial) rather than from another mold.

*Reprinted from Industrial and Engineering Chemistry, News Edition, 17, 461, (1939).

[1]Ekko (trade-mark) is a phonetic spelling of "echo," suggestive of the duplicating nature of the process. The steps resulting in its successful development are the subject of a number of applications for patents.

Figure 4 shows halves of mold for making the hand shown at right.

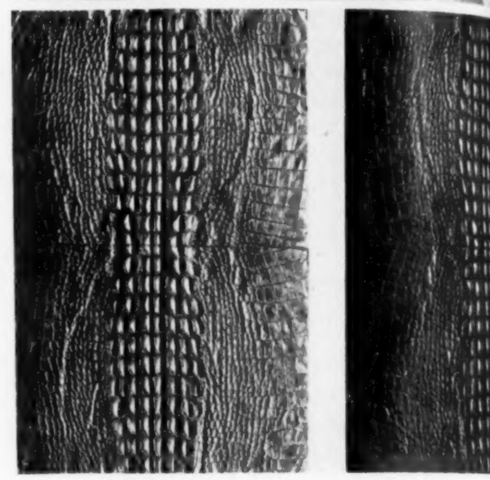


Figure 5 shows a mold made by electroforming on alligator leather (left) and a piece of rubber cured in this mold (right).

Extensive work on the technique of iron plating by the United States Rubber Co. has now resulted in its successful application to the preparation of molds and dies. This article describes a number of these applications and indicates the wide scope of problems in which the process may be used effectively, usually with decided savings in cost.

Description of the Process

It should be recognized that the process is essentially a method of duplication. Exact duplicates of existing molds can be made, or molds may be prepared from objects which may be of practically any material. It is not possible, by direct application of the process, to make a mold for which only blueprints are available, for in this case, either a single cavity mold, which can then be duplicated, must be made or the object itself must be made in wax, plaster, or preferably in a soft metal, after which an iron mold can be prepared by electroforming iron on this sample.

Where it is desired to make duplicates of an existing mold, a pattern, preferably of a suitable metal, such as Cerrobase,[2] is prepared from the mold and plated with iron. Some molds for rubber goods have undercuts, and in these cases it is necessary to make the patterns of rubber so that they can be removed from the mold without breakage.

If the pattern is completely covered with iron during the electroforming operation, it will be obvious that, when the plated metal is cut in two to obtain the halves of the mold, there will be a loss of metal at the parting line. This is usually taken care of by providing extra space at the parting line on the original model so the halves can be separated and faced back to the desired margin. If the parting line is in a single plane, this is simple, but where it is irregular, the problem is more difficult and special treatment is required.

The thickness of the iron deposited by the Ekko process depends on the requirements for the individual mold and the method by which the deposited metal is to be backed by other materials. For many uses, a 0.375-inch layer of electrolytic iron is satisfactory, and it is possible to deposit this thickness in about 2 weeks. Thinner layers are deposited proportionately faster. If more than 0.375 inch is required, the rate of deposition is reduced by the necessity of frequently removing the article from the bath, so that excess metal at corners or "trees" may be cut off.

The two weeks required for a 0.375-inch layer compares favorably with the time required for engraving a complicated design. It should also be borne in mind that where a number of molds are required, the corresponding patterns may be started in the electroforming tank at the same time so that all will be completed in the two weeks' period.

The iron solution which has been developed has unusually good throwing power, making it possible to plate models or patterns of very irregular shape. However, deep recesses do offer difficulties and may require special treatment, such as the use of metal inserts. In some cases, it is possible to make a metal insert corresponding to a deep recess in the pattern and to insert this in the pattern before it is placed in the electroforming bath. When this is done the insert becomes an integral part of the electroformed shell during the plating.

There is practically no limit to the ability of the process to reproduce fine detail. The deposited metal follows the pattern so perfectly that it has been possible, for example, to make an iron phonograph record which gave a faithful reproduction. Diffraction gratings with 7400 lines per inch have also been reproduced in electrodeposited iron. It will be apparent that the intricacy of detail in the original has little bearing on the cost of reproduction.

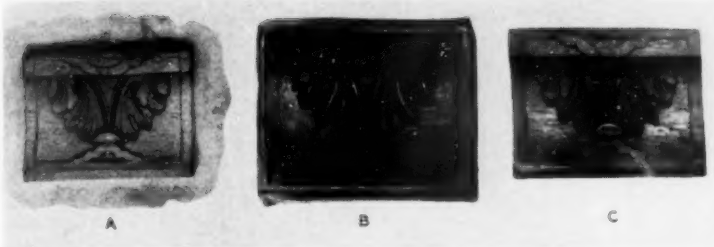
The deposited iron is of high purity, a typical sample giving the following results:

	%
Carbon	0.007
Copper	0.006
Manganese	0.004
Phosphorus	0.001
Silicon	None (5-gram sample)
Sulfur	0.001

The metal is substantially free from porosity. Tensile strength is about 40,000 pounds per square inch. Hardness of the untreated metal is 37 scleroscope or 240 Brinell. By heat treating, the metal can be softened to the normal value for pure iron. It can be readily hardened by carburizing or by other standard methods, such as cyaniding. Before hardening, the metal can be easily machined or welded by any of the usual methods.

Electrolytic iron has a heat conductivity nearly twice that of cast iron or steel. This is a special ad-

[2]Cerrobase is a Bi-Pb alloy, melting point 255° F., with non-shrinking characteristics. Obtainable from Cerro de Pasco Copper Corp.



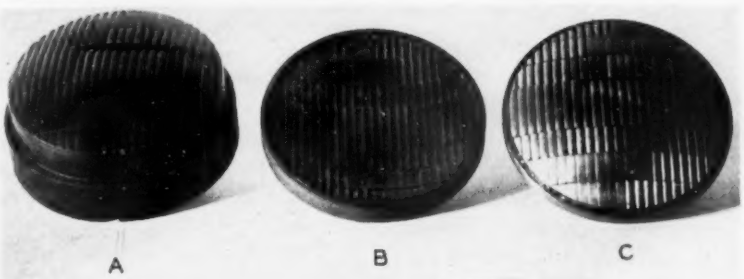


Figure 6 (top) shows mold for making facsimiles of carved mahogany. Figure 7 illustrates making of molds for glass making.

vantage in those types of molding operations where high rate of heat transfer is desirable.

After the plating operation is complete, the deposited metal is separated from the original pattern and prepared for use as a mold or die by mounting it in a suitable frame or back. The mounting may be done in a number of ways, depending on the service requirements. If the object is circular, it can usually be turned for a press fit into a machined steel or cast iron back. Irregular shapes can be backed with cast metal, such as babbitt, aluminum, or cast iron, or in some cases with sprayed metal. Where the pressure requirements are low and heat conductance is unimportant the backing may be plaster of Paris or the harder synthetic stone materials.

Applications of the Process

The largest molds which have been made by the process are for tires, and since their production illustrates the more important points they will be the first described. In Figure 1 the manufacture of a tire mold is illustrated. *A* shows a standard tire mold which it is desired to duplicate. *B* is a rubber pattern obtained from mold *A*. This pattern is rendered conductive by graphite dusted on its surface, after which it is placed in the electroforming tank. When the desired thickness of metal has been formed on the pattern, the electroformed shell is removed. It appears as in *C* when the trees and irregularities have been smoothed off, and weighs about 80 pounds. The shell is welded into a heavy back or case, as shown in *D*, after which it is ready for service.

In some cases, the electroformed shells may be backed by casting aluminum around them. Sections before and after such a casting operation are shown in Figure 2.

Figure 3 illustrates the production of a mold from the object rather than from another mold. The plastic radio dial was plated directly with iron. The iron shell when separated and backed becomes a mold in which exact reproductions of the original piece may be made. This case also illustrates the ease with which raised lettering or lines in a mold may be obtained by electroforming, compared with the difficulty of doing it by engraving where all the adjacent metal has to be removed. In the Ekko process, it is only necessary to start with a pattern or object in which the lettering is depressed to obtain raised letters on the mold.

Figure 4 shows both halves of a mold for producing the rubber hand shown at the right. In this case, a plaster cast was first prepared exactly like the desired shape of the hand. The plaster cast, used as a pattern in the electroforming tank, was plated with iron. It was then separated into two sections, which were backed with aluminum to form the finished mold. Since this process makes it possible to work from plaster casts, it can be used to produce hands or limbs closely resembling those lost through accident or surgery, with provision for an accurate fit at the stump. The hand illustrated was one of three which have been made of sponge rubber to replace hands lost in accidents.

Natural surfaces of all types can be faithfully reproduced. In Figure 5 a mold made by electroforming on two pieces of alligator leather is shown at the left with a piece of rubber cured in this mold at the right. Embossing plates duplicating any natural grain can be made from electroformed iron and further hardened, if desired, to give extremely durable plates.

A further illustration of the reproduction of a natural surface is shown in Figure 6. It was desired to make rubber facsimiles of a piece of carved mahogany. A cast was taken from the piece and sprayed with Cerrobase with a metal spray gun to produce *A*. The metal is so cool under the

Figure 8 (see text)

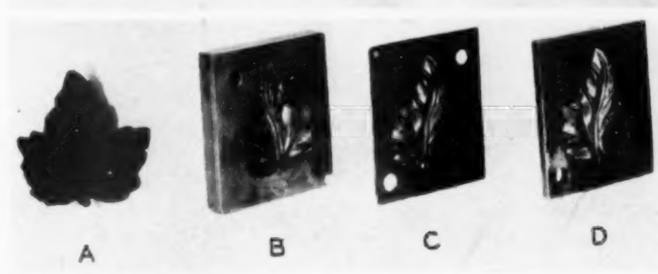


Figure 9 (see text)

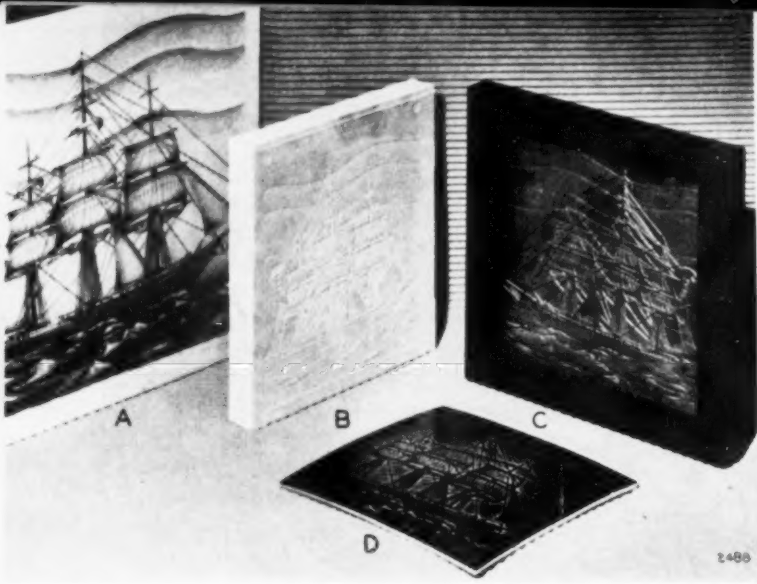


Figure 10
(see text)

spraying conditions that it can be sprayed directly on wood or even against the hand without injury. The sprayed reproduction was covered with electroformed iron to obtain the mold shown at *B* from which the rubber piece *C* was made. The finished piece carries the grain and all the details of the original.

An application to glass molding is shown in Figure 7. The iron plunger, *A*, is approximately 6 inches in diameter. Its surface has been very carefully shaped to produce a headlight lens in which each of the cylindrical lenses will have the curvature needed to direct the headlight beam to the desired point. The duplication of this plunger by engraving or metal working methods is tedious and expensive. A duplicate may be prepared by electroforming, by first making the intermediate pattern or impression, *B*, on which iron may be electroformed to produce the shape, *C*, duplicating the face of the original plunger in dimensions and curvature.

Because the electroformed metal may be made "glass hard" if desired, it can be applied to many stamping and forming operations, for the making of dies or of forces or punches which press the metal into the die. By starting with the article it is desired to reproduce, it is possible to form both the die and force (or pad and punch) at the same time. The desired clearance between force and die will thus be obtained without any necessity for hand fitting. The die and force shown in Figure 8 illustrate such an application. In this case a handmade bonbon dish served as the pattern. By forming the iron on both sides of the dish and subsequently separating the inner and outer layers, both die and force were obtained. It seems probable that this method will find extensive application in the preparation of many stamped articles. It would permit the reproduction of rare designs and old pieces where only a single sample may be available. Because of the perfect fidelity with which the original is copied, all the details and evidences of handicraft in the original will carry through into the reproductions.

As a further development of the process it is possible to prepare a punch and pad for stamping where the original design may have been only a relief in plastic or other material. This method is shown in Figure 9. A leaf design of plastic material, *A*, served as the original pattern on which the pad or die, *B*, was electroformed. After removing the original pattern, the die was returned to the plating tank and a separable layer 0.010 inch thick was plated. On the surface of this layer another separable layer was then formed to about 0.25-inch thickness. The three layers were then separated and the intermediate piece, *C*, was discarded. The pieces, *B* and *D*, after hardening, constitute a pad and punch with clearance established for the 0.010-inch thickness of metal to be stamped.

Possibly the most striking application of the process is in the production of dies or molds in which photographic likenesses can be transferred to iron. This step involves the application of an intermediate photographic process which has been recently developed.[3] By this process it is possible to transform a photograph or negative into a three-dimensional relief in which the shadows in the original picture will appear as depressions in the relief while the highlights will be raised. From the plaster casts produced, iron molds or plates can be made in which a photographic likeness of the original can be obtained.

The steps involved are illustrated in Figure 10. *A* is the picture chosen for reproduction. *B* is the plaster cast obtained by the special photographic relief process. From this, the iron mold *C* was made and in it a slab of plastic *D* was formed, reproducing the design in relief. To bring out the highlights and shadows a colored lacquer was applied and allowed to run off the high spots before drying. Figure 11 shows another example with negative *A*, the iron mold, *B*, formed after the intermediate steps just outlined, and the final reproduction in plastic, *C*.

The process is not limited to photographs of people or scenes, but can be applied to transfer designs in black and white to a corresponding relief and thence to a mold or embossing plate. Because of the photographic step, enlargement or reduction offers no difficulties and the same design may be produced in a whole series of sizes—for example, for a series of plates or dishes of varying diameter.

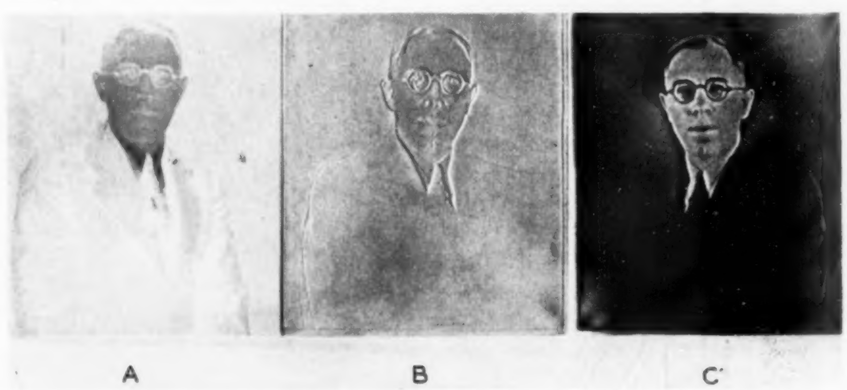


Figure 11. Production of dies for producing photographs with relief effects. A—negative; B—iron mold; C—final reproduction in plastic.

[3]Ford Ceramic Arts, Inc., 4591 North High St., Columbus, Ohio.

Racks vs. Wires in the Gold Plating Industry

By Joseph B. Kushner, Ch. E.

Personalized Plating Service Co.

The author presents a thorough discussion of the relative advantages and disadvantages of racks and wires for gold plating. The drag-out losses, labor of racking and metal losses are stated to be considerably less with racks than with wires in spite of the flash nature of the deposits. A method for recovering gold from plating rack hooks is described.—Ed.

If gold plating plant executives realized the savings they could make in time, money and labor by using racks instead of wires for their production plating work, they would insist on the use of racks.

The plating rack has superseded wire as a cathode mounting in almost every field of mass electrodeposition but the gold plating industry obdurately clings to wire, much to its detriment. Plating superintendents have streamlined their plating rooms and have insisted on modern, efficient racking for their brass, chromium, and nickel plating but electrogilding goes on for the most part, in the same way it was done 100 years ago. Little strings of work on wires, the plater desperately trying to keep them disentangled so the work won't scratch; a quick vibratory contact with the cathode busbar in the little pot; then rapid withdrawal with half the solution dragged out. And this is what is called production gold plating!

Unfortunately, in many cases where the executive does realize his electrogilding practices are behind the times, the department is in charge of an old line plater who because of prejudice or an unreasoning fear that he will be replaced by a lesser salaried person if operations are too much simplified, stubbornly resists any attempt at scientific modernization. Due to the fact that there are a great number of different types of finishes with gold, color variations and lack of analytical control, the management is to a large extent in the hands of the plater, on whose little dodges and "tricks of the trade" it must rely in order to get the finish desired for the merchandise. Each plater has his own special methods and it often proves difficult to find a plater who can duplicate a previous plater's results. Thus, unless the plating room is in charge of a scientific plater or chemist, the executive is stymied in his efforts to reduce cost and improve production.

Joseph B. Kushner

Perhaps this backward condition stems from the fact that the electrodeposition of gold is the oldest of the metal plating arts and "it's hard to teach an old dog new tricks," as its younger brothers, nickel and chromium plating were taught to use racks. Perhaps it is because gold being comparatively expensive is deposited only in flash thicknesses in the majority of cases, seemingly making racks unnecessary; perhaps it is because of disinterest, but whatever the reason against racking in gold plating, it is unjustified.

The purpose of this paper is to compare the rack with wire as a cathode mounting medium for production gold finishing work and demonstrate the marked advantages in favor of racks. Let us consider first the alleged disadvantages of racks.

Probably the foremost objection to racks in the executive's mind is: (1) "They cost too much money to make." But do they? The materials of rack construction are generally copper, phosphor bronze wire and rubber. These are certainly not expensive items. The initial cost is mostly that of the labor that goes into the design and construction of the rack. Once an efficient design has been worked out, similar racks can be fabricated simply and cheaply by use of jigs or forming tools or else any number of duplicates can be reproduced by one of the plating rack manufacturers. Because modern types of rack insulation are long enduring even in cyanide solutions, and can be replaced quite inexpensively should they wear out or break down, the upkeep on a rack may be considered negligible. If the increase in efficiency, the saving of time and labor and the reduction of gold losses and copper costs that the use of racks brings about are considered, the plating rack becomes no longer a costly gadget, but a vital neces-

sity for saving money in the electro-gilding plant.

A common objection to the plating rack is: (2) "A rack plates out too much gold on itself in flash work." While it is true that most gold finishing work consists of momentary immersion in a plating tank (flashing) and it is also true that gold is an expensive metal to waste, nevertheless an objection on this basis is unwarranted, because *insulated plating racks pick up less waste gold than wires holding an equivalent load of work.* Let us see why this is so with an actual case in point. A rack designed by the writer for gold plating work on certain electric razor heads exposed less than ½ inch of bare contact wire per piece mounted. This wire was No. 16 B.S. gauge phosphor bronze. In the plant where this plating was formerly done, the work was mounted on wires. No. 22 B.S. gauge copper wire was used. It was found that a separation of at least 4 inches on the wires was necessary in order to avoid bumping and scratching. For an initial flash plating of 0.00001", how much gold went on the wire per piece and how much gold went on the rack?

With sufficient accuracy, the diameter of No. 16 wire is 0.05" and that of No. 22 is 0.025". The volume of gold deposited on the rack per piece is therefore 0.05 x 3.14 x ½ x 0.00001, where 3.14 is the approximate value of pi. The volume of gold deposited on the wires per piece is 0.025 x 3.14 x 4 x 0.00001. Since we are interested only in the relative amount of gold deposited, dividing the first result into the second gives the surprising fact that four times as much gold goes on the wire as goes on the rack!

$$\frac{\text{gold on wire}}{\text{gold on rack}} = \frac{0.025 \times 3.14 \times 4 \times 0.00001}{0.05 \times 3.14 \times \frac{1}{2} \times 0.00001} = \frac{4}{1}$$

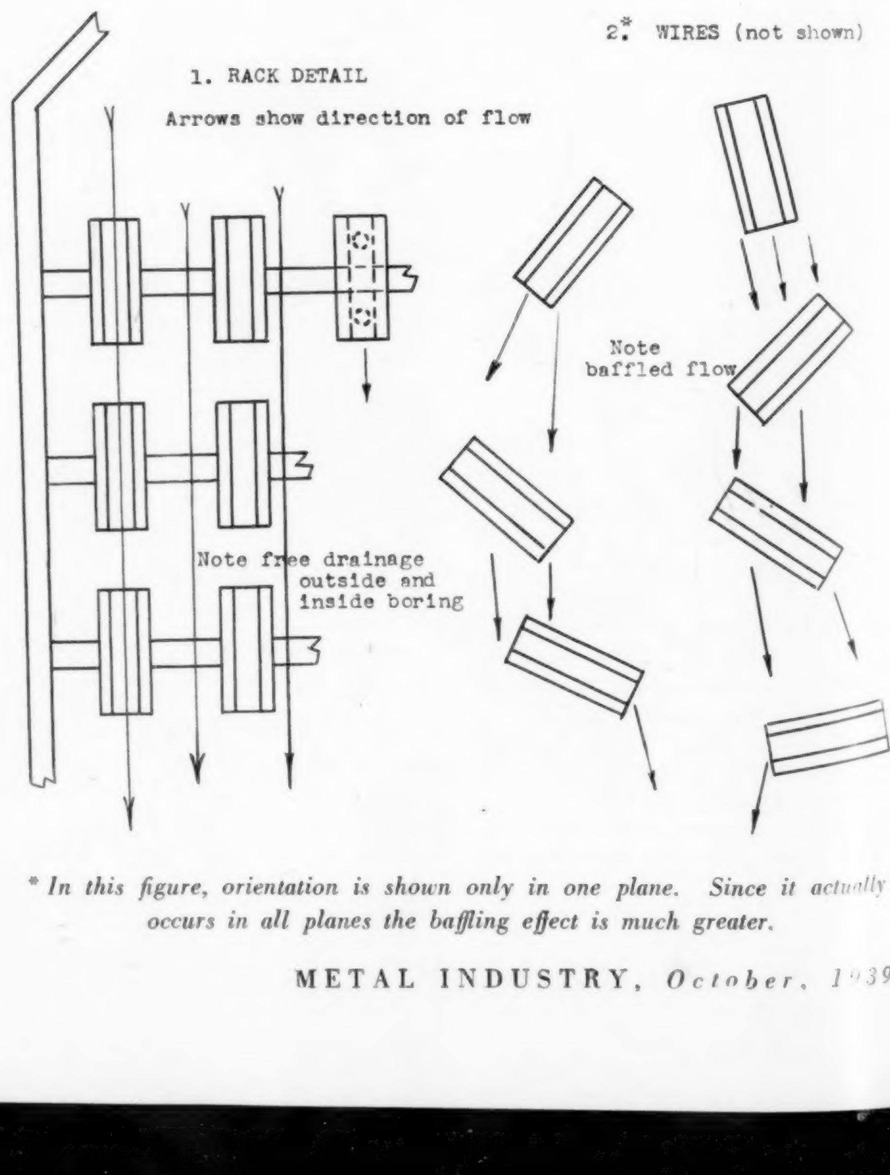
It will be found that in almost all cases more gold goes on bare wires than on the racks with equivalent loads, provided the racks are sufficiently insulated.

Another objection to the rack is: (3) "Plating racks increase drag-out losses." Is this true? For all properly planned racks, the answer is no. *Correctly designed plating racks cause less drag-out loss than wires carrying equivalent loads.* Why? Because on a rack the pieces are rigidly mounted and therefore may be so suspended as to produce maximum drainage, whereas on wires the pieces take random positions, unavoidably oriented at all angles, especially when clumped together, and act as effective baffles and traps, preventing free drainage and entraining a large volume of liquid. The illustrations shown here, for the particular case of razor heads, explain this.

The main body of the rack may increase the drag-out by a small amount, but with full load the total amount of liquid removed is less than that dragged-out by wires equally loaded. The insulation on the rack is not easily wet by water and sheds it like duck's feathers. Incidentally, if the rack is streamlined as suggested by Soderberg[1] there is no doubt that the overall drag-out can be still further reduced. Another factor in drag-out is the time of removal from solution. As was demonstrated by Soderberg, the more rapidly the cathode is removed from the plating bath, the more electrolyte it drags out. A well balanced rack is more easily controlled and is more amenable to slow removal and careful rinsing than a mass of closely bunched objects on wire. In the particular case given previously as an illustration, no actual figures on drag-out were recorded but from observation and experience the writer ventures to say that the drag-out per piece for equivalent load on wires, was at least 20% greater than that per piece on racks.

Another objection is: (4) "A plating rack introduces increased weight, making it difficult to handle comfortably in flash work." This objection may be warranted if the older types

FLUID DRAINAGE FROM RAZOR HEADS MOUNTED ON A RACK AND MOUNTED ON WIRES.



** In this figure, orientation is shown only in one plane. Since it actually occurs in all planes the baffling effect is much greater.*

[1]G. Soderberg, Monthly Review A.E.S., 24, p. 156 (1937).

of clumsy, uninsulated racks are being considered, but it no longer holds for modern, insulated racks. Time was when a plating rack originally weighing a few ounces would gain a pound or so during a short period of use but this no longer occurs as racks are now insulated thoroughly. A correctly designed rack should be in balance at full load and if the rack is balanced, the matter of small increased weight has no significance. As a matter of fact, it is easier to manipulate a loaded rack that has the right "heft" than a bunch of twisted weighted wires.

A fifth objection may be: (5) "The contacts on racks become stiffened with increasing use." This may hold true to some extent in the case of nickel or chromium plating where the metals deposited are hard and brittle and the thickness of plate may be substantial, but this does not hold for gold. Gold is an extremely ductile metal and does not perceptibly stiffen the contacts even after long use, especially under flash conditions where a thickness of 0.0001" or more is the exception and not the rule. Then again, racks can be obtained with removable contacts that are replacable by merely screwing in new ones in the main body of the rack frame. There is also the alternate possibility of stripping the gold from the rack contacts, which once more restores them to original dimensions. This method will be described later on.

Some of the alleged disadvantages of racks in gold plating have been refuted. Now let us consider the advantages of plating racks.

1. Racks Save Time and Labor, Speed Production

In order to insure contacts on wire, care must be taken with each piece, properly twisting the wire around each object, etc. After plating, cutting and untwisting are necessary to remove the pieces from their support; with racks this is eliminated. One or two simple motions are all that are needed for mounting and demounting and the contact is sure and secure because of pressure or tension. As an example of the time saving possible, the same illustration may be given. It took a racker less than 5 minutes to fill up the rack with 72 pieces whereas it took the same person approximately a minute to wire 5 pieces. At this rate, to mount 72 would take about 15 minutes or three times as much time. Similarly, in unracking, at least this much time is saved. Production can be sped up because it will be found that in many cases *a plating rack can carry more pieces in a given volume of space than wire*, without danger of bumping, scratching or shading. The reason for this is obvious. On a rack, the pieces are uniformly distributed because they are rigidly suspended and a saving in free space is available without detriment to the piece or the deposit. On wires where the pieces must be widely spaced, and the number of wires that can be bunched together is limited by poor separation, shading and bumping, the amount of pieces carried is necessarily much less. As a valid proof of this statement, the writer cites from the example given previously. The rack holding 72 pieces could be easily handled by the plater but the most he could handle safely on wires at one time was 20.

Since by the use of racks such savings in time, labor and increase in production become possible, the executive or foreman can shift or re-assign the time and labor thus freed to other more profitable uses for furthering and improving production.

2. Racks Reduce Copper Costs to a Minimum

Racks can be used time and again, indefinitely. Wire once used must be thrown away as it becomes twisted and kinked. This, where much plating is done, represents a considerable copper loss. Simple calculations prove this. Figuring the average length of copper wire used per piece as 4 inches and the gauge as No. 22 B.S., the weight of copper per piece plated equals

$$0.0015 \text{ x } \frac{4}{12} = 0.0005 \text{ lb.}$$

where 0.0015 is the weight in lb. of 1 foot of No. 22 wire (copper). If 1,000 pieces are plated, then according to this, ½ lb. of copper is consumed. In plants where as many as 30,000 pieces are plated daily, the sizeable weight of 15 lb. of copper is used daily. Figuring 300 working days per year, the total weight of copper lost is 4,500 lb. or over 2 tons of copper! If the wire sells at around 20 cents a lb., the copper cost is $900. Compared to this, the small initial outlay for racks is an investment that pays for itself many times over.

3. Gold on Rack Contacts Is Easily Recovered

On wires, in many cases, gold goes to waste. There is a tendency to throw away used wire as scrap even though there is a deposit of gold on it. If the wire is saved and sent to the refiners, it still is a decided nuisance for the plater to collect, and the returns may not pay for the trouble involved. The gold on rack contacts (if the rack has been insulated for use in cyanide solutions) is easily removed by making the rack anode in a mild cyanide solution and electrolyzing at a low current density at a temperature of about 50°C. with copper cathodes. This is continued until most of the gold on the contacts has been dissolved off (some must be left to protect the underlying copper); the rack is then ready for use again. If it is desired to keep the gold in solution instead of having it deposited on the copper cathodes, these may be placed in a porous pot containing the same concentration of cyanide as is present in the main body of the solution and the electrolysis performed as before.

Alternately, it is possible to have the racks built with removable contact points, i.e., the points can be made to screw into the main body of the rack. Thus when the contacts are too heavily coated with gold to be of further use, they are easily removed and the gold recovered. The contacts can be replaced by another inexpensive set.

4. Racks Improve Deposition; Increase Bath Life

In the case of gold flashing solutions where high cathode polarization and good throwing power bring about uniform deposition of metal, the fact that a properly designed plating rack can bring about more uniform deposition is not a vital advantage. However, if heavy plates are to be deposited, current distribution becomes important. Because of the

solid body of the rack, pieces can be so mounted as to reduce inequalities in current density. With wires, such arrangements are impractical if not impossible.

As was shown earlier in this article, in general, more gold is removed from the bath by wires than by a rack carrying an equivalent load. This slight though constant loss of gold from the bath when coupled with that withdrawn by drag-out, brings about an unbalancing of the plating solution which leads to its early loss of proper plating characteristics and consequent discard. This is especially true where non-scientific, hit-and-miss methods are used for replenishing the bath. Racks, in reducing this steady, appreciable loss of metal that is often not accounted for, help retard the unbalancing of the solution and thus increase the life of the gold plating bath considerably.

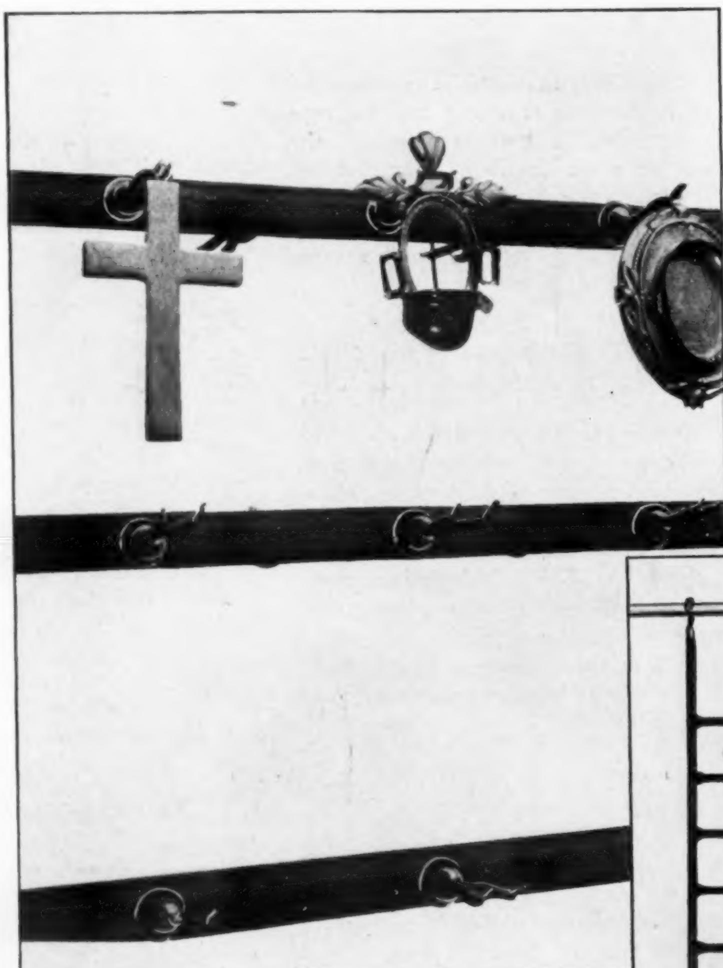
5. Racks Reduce Current Consumption

While admittedly a minor advantage in the case of gold plating work, the fact that less current is consumed by an insulated rack than by bare wires carrying an equal load is nevertheless true, and may in certain cases prove of value.

6. Racks Are the Only Possible Mountings for Automatic Gold Plating

This advantage which perhaps should have been mentioned in conjunction with advantage (1) is self-explanatory. If production is to be sped up by mechanization of operations, racks are the sole choice, wires are totally out of the question There are several plants with automatic electrogilding apparatus in operation at the present time and the racks used are performing excellent service.

All of the advantages offered by the use of plating racks in preference to wire that have been pointed out in this paper are definite, worthwhile advantages that should not be foregone, save only if the work that is plated does not lend itself to racking because of size, shape or other peculiarity. In most cases, a conference between the rack designer and the plater will result in a suitable rack design for the purpose at hand. In some instances where the object as is, cannot be racked, a slight modification or change will make it amenable to racking. In any event, racking problems may be safely left in the hands of a rack manufacturer, who in nine cases out of ten, will be able to supply the racks at a moderate cost and thus enable the use of racks to save time, mone and labor in gold plating work.



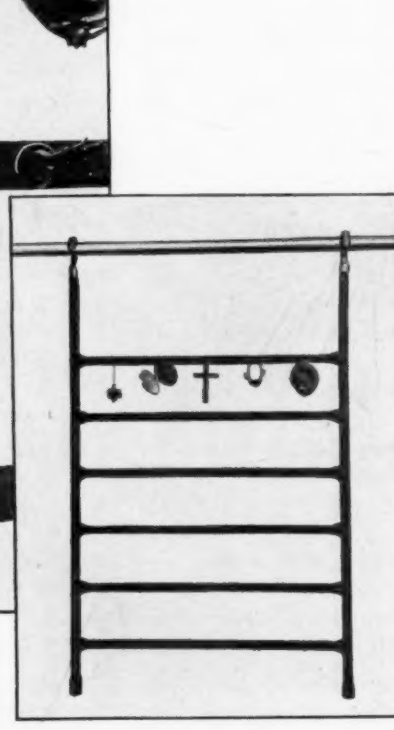


Fig. II. Rubber insulated racks showing racking of various types of work to be gold plated.

(Courtesy Belke Manufacturing Co., Chicago, Ill.

The Effects of Temperature On Plated Coatings

By Phil Ritzenthaler

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Cutler-Hammer Inc.,
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The effects of prolonged heating of plated coatings on their junction conductivities were studied. Cadmium and nickel electrodeposits were found to be satisfactory as contact metals at elevated temperatures with cadmium having the lower contact resistance. Zinc coatings develop high resistance films which make them unsuitable for electrical contact purposes at elevated temperatures (250°-300°F). Zinc coatings on copper and its alloys flaked off under heat leaving a black, high resistance layer. Tin is not recommended for electrical contacts which must withstand heat.—Ed.

Introduction

Many data have been presented to the plater and those who use electroplating on the conditions of electrodeposition—as for example, current density, solution composition, etc. The plater's work is often considered complete when the plated pieces leave his department. However, the performance of the plated article in service under various field conditions is certainly as important. While we often think of service life of a coating in terms of useful life when exposed to a certain corrosive atmosphere, there is another, and oftentimes neglected phase, namely, the effect of temperature on plated coatings.

This may include the accelerating effect of heat on the rate of corrosion in certain atmospheres, but of greater import, in many cases, is the effect of temperature in causing intermetallic diffusion or alloying between the plating and base metal. This often gives rise to new alloys, with physical, chemical and electrical properties markedly different from those of the reacting metals. If this can happen to plated coatings, then it certainly is important to know what the characteristics are of the products formed by action of heat on a plated base.

Phil Ritzenthaler

Diffusion of Metals

While diffusion does occur on iron and steel when coated with zinc or aluminum at elevated temperatures, by far the most active alloying combinations are found in the non-ferrous group of metals.

Diffusion between various electrodeposits and basis metals has long been known for such combinations as copper on zinc, gold on lead, gold on brass or zinc, and cadmium on copper. Copper on zinc is one of the most important in this age of zinc base die castings. Many investigators have considered the interdiffusion of these metals. Castell[1] and Binayendra Nath Sen[2] have shown that the diffusion is largely from the copper into the zinc. W. Meyer[3] pointed out that diffusion in itself was not necessarily bad unless the diffusion alloys formed were more brittle than either metal. If brittle alloys are formed, as in the case of copper-zinc alloys, or iron-zinc alloys, then peeling or flaking may result, due to a marked decrease in ductility. It is the absence of this brittle layer on electrogalvanized wire which is largely responsible for its adoption instead of hot-dip galvanized wire, as electrogalvanized wire may be freely bent without flaking.

Junction Conductivities

Of great importance to our company, as electrical manufacturers, in addition to the knowledge of physical properties, is the electrical conductivity of the diffusion alloys formed, as well as the overall conductivity of the plated metal after exposure to heat. Many of our plated parts carry current or are heated by radiation from other parts of an assembly.

As available data on effects of heat on electrical properties of plated metals were very limited, it was decided to undertake a series of determinations with various combinations of coatings on copper base metal, as this is the most commonly used conducting metal.

Before this test started, however, a serious incident occurred in the shop which emphasized the large change in resistance which could occur due to the aforementioned effects. This was about the time of

the cadmium shortage which resulted in our increased use of zinc plating as a substitute. We had made a blanket change of cadmium to zinc on most parts, including many non-ferrous parts, and among which was a copper rivet. This zinc plated rivet was a part of the circuit in a small overload device, and was subjected to a short bake at 300°F. during the calibration of the device. When these zinc plated rivets were assembled, and the device was tested, the calibrations varied by as much as 25% due to the change in conductivity of the rivet. When examined, the rivet had turned coal black and no zinc was visible on the surface due to the diffusion of zinc coating and base metal or oxidation. In fact, some rivets when tested for contact resistance gave such high readings they were practically insulators. As all of our electrical devices are closely calibrated, it can readily be seen how detrimental such a condition could be.

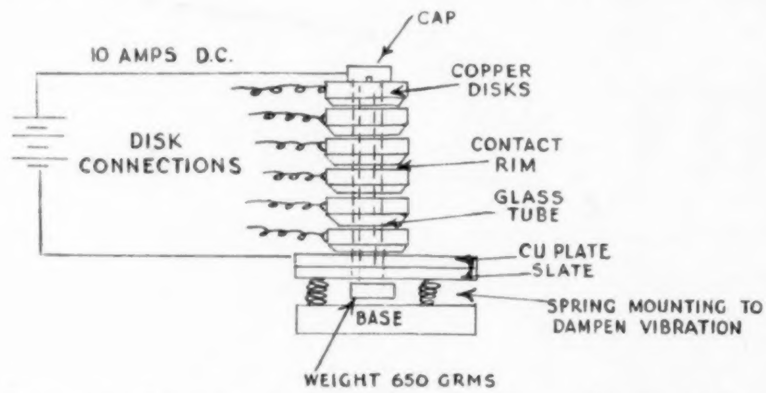


Figure 1. Apparatus for measuring junction resistances between plated metals.

Testing Procedure

The following is a description · the apparatus used. To cancel out individual errors, a pile of six copper disks was used for each metal combination. This allowed individual reading between disks and also total resistance readings for averages to be taken. The disks were one inch in diameter with the contact ring 1/32" thick and 9/16" in diameter and the upper face a smooth, flat surface. Each disk was drilled to permit insertion of a glass tube through the center to line up the stack. The bottom disk rested on a flat one, which in turn rested on a slate block mounted on a steel pedestal.

Pressure was maintained between contact surfaces by hanging a brass weight of 650 grams by an asbestos cord from a copper cup which rested on the top copper disk. In this way, uniform pressure, independent of vibration, was assured between the disks. Electrical contact to each disk was made by tapping it and screwing down the lead. Connections were also made to the top cup and base disks of each stack so that current could be passed through the stack for resistance measurements.

The contact surfaces were made smooth and flat before plating and were not finished in any way after plating. Four stacks were plated as follows:

(1) Bright zinc 0.0005" thick (cyanide bath)
(2) Alkaline tin 0.0005" thick (stannate bath)
(3) Cadmium (bright) 0.0002" thick (cyanide bath)
(4) White nickel 0.00025" thick (cold, single nickel solution)

In addition to the above-mentioned plated disks, additional plated pieces of sheet stock finished as given below were hung in the oven to observe the effects of heat:

(1) 0.0002" cadmium on brass, bronze and copper base.
(2) 0.0005" bright zinc on brass, bronze, copper and steel.
(3) 0.0005" electro-tin on brass, bronze and copper.
(4) 0.00025" white nickel on brass, bronze and copper.

Six samples of each were made so one of each could be removed after each temperature step.

The procedure for testing was to first take the initial contact resistance of the stacks at room temperature. This was done by passing a current of 10 amperes through a stack and observing the potential drop between successive disks. After this was done, the stacks and samples were placed in an oven and the heat was turned on. The temperature was maintained for two weeks at each of the following temperatures: 130°C, 160°C, 190°C, 220°C and 270°C, after which it remained at room temperature except when raised again to 250°C for one hour. After each of these periods, one of the sample sheets was removed from the oven and mounted on a board for later study.

1. Tin Plated Copper

The tin plated contacts had the lowest initial contact resistance, but when the first "official" contact measurements were made, the values had increased considerably and there were pronounced differences between successive disks. This points to formation of surface films. The range was from 9 x 10^{-5} ohms to 312 x 10^{-5} ohms. Resistances seemed to decrease during the tests. At the conclusion of the tests, the disks were uniformly dark grey, and adhered to each other very strongly. When broken apart, the break looked brighter and more metallic than the rest of the disk. This points to a sort of soldering action of tin to tin. In fact, at a temperature of 220°C, contact resistance dropped to zero indicating a fusion of the tin. That this effect goes on below the melting point of tin is shown by the gradual drop in the resistance.

2. Cadmium Plated Disks

While resistance measurements were being made, the contact resistance of these disks fluctuated considerably, but became stable at 130°C and remained fairly stable during the test. Disks turned to a fairly uniform greenish brown. Some sticking of disks was noticeable. Contact resistance decreased from 0.01 ohms at room temperature to 0.00035 ohms at 270°C. Thus cadmium seems very satisfactory for contact work.

3. Zinc Plated Disks

Readings on contact resistance were steady at room temperature, but jumped abruptly when the oven was raised to 130°C (266°F) and rose to

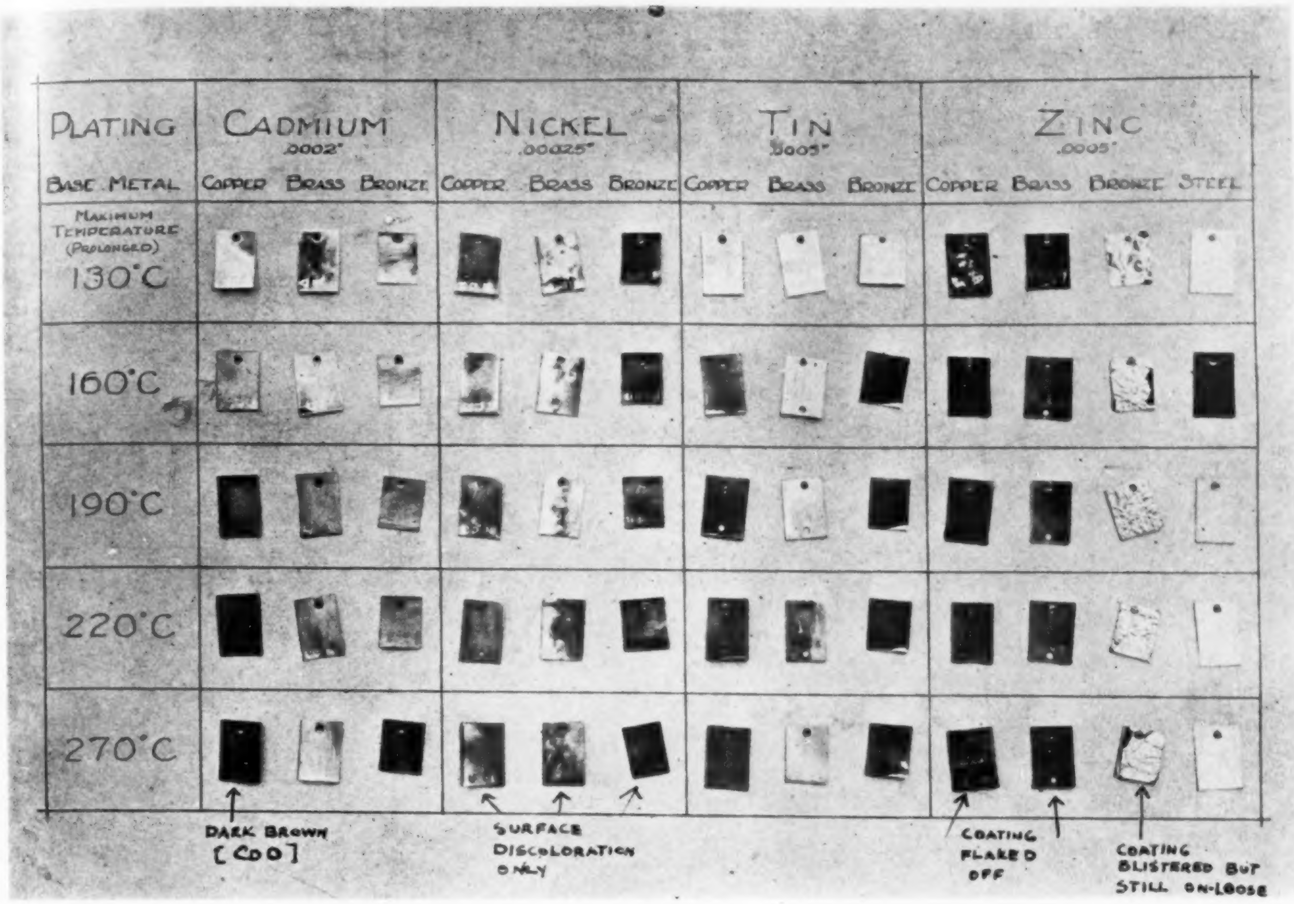


Figure 2. Effect of temperature on various plated metals.

an average value of 10,000 ohms at higher temperatures. In fact, in the time-resistance curves it was noted that the zinc line went right off the graph. This means that resistance increased so markedly that this combination is practically an insulator. This shows graphically what had happened in the shop on exposure of the zinc plated copper rivet to heat. Disks were dark grey in color with little or no sticking together. Zinc, therefore, is highly unsatisfactory where it is exposed to even mild temperatures.

4. Nickel Plated Disks

At room temperature both before and after the heat test, the contact resistance of nickel seemed to increase while measurements were being made. Resistance of nickel-copper combinations did not change greatly with temperature but remained fairly constant. There was only slight surface discoloration and no sticking. This is in keeping with the relatively inert nature of nickel at these temperatures. Nickel, therefore, is satisfactory where elevated temperature is to be met, but does not have as low a resistance as cadmium or tin.

Exposure Results on Exposed Strips

Below are listed the results from exposure of plated strips of brass, bronze, copper and some steel to the temperatures and times as given above. These results are shown on a photograph, Fig. 2. These strips were hung in an oven along with resistance stacks and the results noted. Unfortunately, it is difficult to convey a true picture of what happened by a photograph. For example, the strips of zinc plated brass and copper appear black in the photograph. Closer observation, however, shows small bright flakes of zinc remaining. What actually happened was that with the first increase in temperature to 130°C, the zinc plating flaked completely off during the two week period, exposing a black layer underneath. The zinc on bronze gave a most peculiar effect. The appearance was similar to a lead foil being considerably brighter in appearance than the original zinc coating.

Apparently there was an increase in volume with the formation of the diffusion alloy, producing a wrinkled appearance. Below this was a black surface layer of high resistance similar to that occurring on brass which had been zinc plated. Zinc, apparently, is the bad actor of the group, as the diffusion alloys which were produced were not only very brittle, leading to flaking, but gave a high resistance to the plated combination.

The black layer itself, has high resistance, but Dr. W. R. Meyer (communicated) suggests that some of the alloys formed may be ionic in nature and hence non-conductors of the same type as some oxides. When examined under the microscope, the zinc on copper gave a very interesting cross section, shown in Fig. 3. On the left side, is the outer layer of white zinc oxidation product. Then comes a layer which we were unable to identify, marked "unknown layer." This appeared granular in nature and probably contained much zinc oxidation products also. The

fine white line was all that remained of the zinc coating. Below this was a thick brass layer, yellow in color, which our metallurgist identified as alpha brass. This is followed by a clearly defined layer of "white" brass, so called because it had a much lighter yellow color than the preceding layer. The unusual feature is the sharp change from one layer to another.

In a diffusion reaction of this type, one would expect a uniform and gradual transition from zinc layer to copper base. This is not the case as can be clearly seen in Fig. 3. According to previous investigators, the diffusion is from copper to the zinc, but in the case of plated zinc on copper this does not appear to be the case, as the alpha brass, copper rich layer is near the zinc and the "white" brass or high zinc alloy is near the copper base.

Fig. 4 is another photomicrograph of the same combination, zinc on copper taken at higher magnification and of a section cut on an angle so as to widen out the layers. Again the "white" brass layer is next to the copper and the alpha brass near the outer zinc surface. Again note the definite line of demarcation between zones.

Fig. 5 shows a cross section of the effect of temperature on cadmium plated copper. While cadmium and copper do diffuse, the reaction is much slower, as seen from the thickness of the layer compared to Fig. 3, and there are no zones evident. Most of the cadmium still remains, although there are oxidation products on the surface (brown cadmium oxide and yellow cadmium sulfide). From a study of the resistance curve the alloying produces no increase in resistance of the combination, so that it is safe to use.

Zinc, on the other hand, rises in resistance until it is a good insulator. This should rule out its use in electrical apparatus.

Following is a summary of observations on strips shown in the photograph Fig. 2.

1. *Cadmium on Brass, Bronze and Copper*—Maximum effect on copper, next bronze, last on brass. A rise in temperature increases the intensity of a brown film of CdO on the surface. No flaking evident. CdO forms fastest, beginning at 190°C (374°F).

2. *Nickel on Brass, Bronze and Copper*—Very little effect, except heat formed a very thin blue oxide film on the nickel surface which looks much heavier on the photograph than it really is. Very little, if any diffusion and no flaking occurred; excellent coating for exposure to heat.

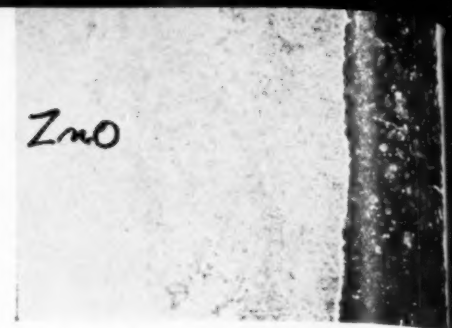
3. *Tin on Copper, Brass and Bronze*—Maximum effect on copper, next bronze, then brass. Tin fused during the 160°C test and alloyed rapidly with copper, giving rise to a brittle black surface coating that appears to be copper oxide. This same effect occurs on bronze. Brass will resist this effect until 220°C. Tin is not recommended for heat. Resistance readings of tin on the disks were good, probably due to the soldering effect between disks with the sealing off of the surface.

4. *Zinc on Copper, Brass and Bronze*—These pictures cannot convey the magnitude of action. Zinc coatings flake off completely, even at 130°C (266°F) leaving underneath, a black, high resistance layer. This occurs on both copper and brass. The effect on bronze is similar, as the coating bond is destroyed and a black layer is formed, but the coating undergoes a remarkable change, as previously described. Zinc on steel will form white zinc oxidation products, but there is no spontaneous flaking.

Summary: Of the combinations tested, cadmium and nickel plating appear satisfactory for use at moderately elevated temperatures, but tin and zinc are not very satisfactory if exposed to the atmosphere. If kept from the atmosphere, the results will differ some, as with the resistance pile. Zinc is the worst combination and is dangerous to use due to a high resistance layer formed and to brittle diffusion alloys produced which lead to flaking.

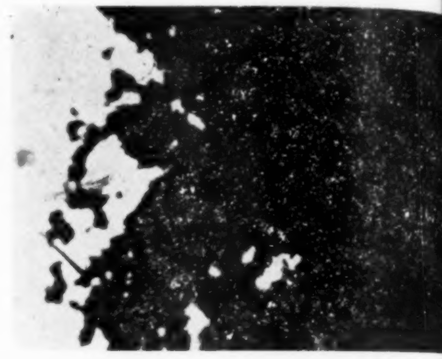
In conclusion, the author would like to thank Messrs. W. Elliot and C. Evans for conducting the tests and to E. Erdman for making the photomicrographs.

The author hopes that the data presented may be of some help to others who have to consider the effects of temperature on plated coatings.



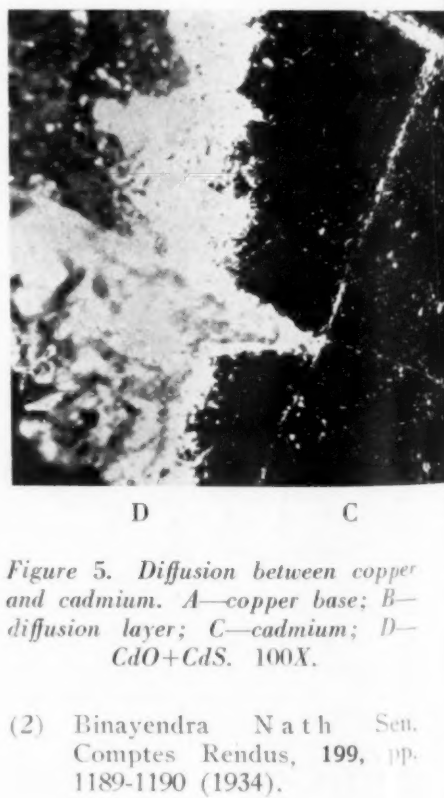
F E D C

Figure 3. Diffusion of zinc plate into copper. A—copper base; B—"white" brass; C—alpha brass; D—zinc; E—unknown; F—zinc oxide. 25X.



D C

Figure 4. Higher magnification of Figure 3. A—alpha brass; B—zinc; C—unknown; D—zinc oxide. 100X.



D C

Figure 5. Diffusion between copper and cadmium. A—copper base; B—diffusion layer; C—cadmium; D—CdO+CdS. 100X.

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(3) W. R. Meyer, Monthly Review, A.E.S., Feb., pp. 11-12, (1936).

PLATING AND FINISHING
FABRICATION — ASSEMBLING
METALLURGICAL — ROLLING
CASTING AND JOINING

SHOP PROBLEMS

Technical Advisors For October Issue

G. BYRON HOGABOOM
Consultant in Electroplating and Metal Finishing, Newark, N. J.

ARTHUR SCHIPKE
Manager of Sales
Hotel Division
International
Silver Co., Meriden, Conn.

When sending solutions for analysis please give following information: name and address; class of work being plated; kind of solution and volume; length, width and depth of tank; temperature of solution; current density, cleaning sequence and any other pertinent facts.

Deposit on Vapor Degreased Parts

Q. We are having difficulty with the formation of a scum on screw machine products after the degreaser has been in use for some time.

Will you please suggest means of correcting this difficulty?

A. Problems of this type should be referred directly to the manufacturers of degreasing equipment because of their wealth of experience on problems such as yours.

However, several possible causes for this trouble may be listed.

1. There may be a material in the oil which is insoluble in the trichlorethylene. Hot trichlorethylene is a very good solvent for most organic materials but, however, certain sodium soaps are not completely removed.

To test whether the scum is a soap residue, merely try washing off the dirt in warm water and if it is removed, then it is a soap. Occasionally, if the deposits of dirt are thick and the metal is of light gauge, then it will become heated to the ambient temperature of the vapor too soon to allow enough vapor to condense to accomplish complete washing. Such light gauge stock is best cleaned in degreasers using a combination of solvent and vapor cleaning. —W. R. M.

Immersion Tinning

Q. The writer has been experimenting on tin plating of small copper plated steel articles by boiling in an alkaline tin bath and has been encountering some difficulties in the process of plating, and would like to explain our problem. If possible, could you suggest reasons for the non-uniform plating.

The articles are placed in a brass basket about 18″ diameter x 8″ high which is run through various cleaning steps, given a copper strike, rinsed, then put into the tin bath where it remains for 20 minutes. Occasionally we find that the top and bottom of the charge are properly plated, while the articles in the middle become black. On small scale tests, we always get good plating. We analyze the bath for tin and alkali before each run and adjust the composition to the one which we have found works best. We make additions during the run to keep the composition constant.

We would appreciate any comment you have to make on this.

A. We suggest that you use an iron instead of a brass bucket.

From the description given, it appears as though your trouble is due to the fact that the mass of work is bipolar in the immersion tin solution. That is, the outsides of the mass are cathodic and are receiving a tin deposit, while the inside is anodic, and is dissolving the copper coating. Use smaller loads, or place tin grids or tin pellets throughout the mass of work.

In immersion tinning, it is necessary to put on more than a flash of copper. If the copper coating is too thin, it will be entirely replaced by the tin and poor adherence, or else a poor color will result. This is an alternative explanation of your trouble.—G. B. H., Jr.

Silver on Hollow-Ware

Q. We would like to know how to designate the amount of silver that is deposited on hollow-ware. We know that flatware is designated by 8-10 or 12 dwt. to the dozen pieces, but cannot tell a customer how much silver to put on hollow-ware.

A. I can only give a rather sketchy outline as an answer to your inquiry inasmuch as each line of hollow-ware has a carefully worked out ratio, and which each manufacturer considers confidential.

There are usually three standards used, which would apply to a coffee pot, for instance, about as follows:

Heavy hotel plate	8 dwts. each
Standard plate	6 "
Non-standard plate ...	3-4 "

All hollow-ware plating is figured on an area basis, also the utility of each article being taken into consideration.

The best way to determine the amount of plating is to strip the article and if badly worn, add about 25% to the stripped amount which will give you a pretty fair indication of what the new deposit should be for the quality desired.—A. A. S.

Blistering of Silver Plate

Q. We have encountered a problem in silver plating. We are plating at the present time in a bath that corresponds to the following:

Silver	18 grams per liter
Free cyanide	51 "
Carbonate	unknown—but probably rather high

We are using a moving cathode rod (very recently installed) which has a stroke of four inches and makes a complete cycle in 3½ seconds.

Our silver strike solution is new and made up as follows:

Silver	1.2 grams per liter
Free cyanide	68 "

We have been applying ½ to 1 volt across our plating bath and about 5 volts across the strike.

The results have been mediocre plating at best, and very often accompanied by blisters and rough spots. Our greatest difficulty is found in plating copper and German silver. These metals had formerly been plated with silver without the use of a mercury dip with fair results, but recently, a hard metal article that plates well has been a rarity. Most confusing are the blisters which occur at random at various places without regard to the manner or point of suspension or position in the tank. They are usually rather small and occur even after a piece appears to strike up well.

We hope that you can advise us in correcting our operation difficulties.

A. The blisters are due to something in either the strike solution or the cleaning methods. We suggest checking on the strike first. To be certain, the strike composition should be checked by analysis.

The silver content of a strike can vary from 0.2 to 0.5 oz./gal. of silver. Your metal content is low. While different metals require different metal content in the strike to get the very best adhesion, satisfactory results can generally be obtained from a strike containing 0.4 oz./gal. of silver and 9 ozs./gal. of free cyanide.

Manipulation of the work in the striking operation will effect adherence. The work should not be allowed to hang in the solution while other wires are being placed on the work rod, as the disconnected work is not only taking on an immersion silver but is also being acted upon as a bipolar electrode. (Part of the surface is cathodic, part anodic).

Check the voltage at the strike, and also the anodes and connections. Work being struck must receive full current in the first few seconds and all anodes must be working. Best anodes for a strike are gas carbon. Steel can be used. Also check connections on silver plating tank.

If trouble continues, send samples of solutions for analysis and also send description of cleaning procedure; also a piece of representative work.

It is noted that the free cyanide in the silver solution is quite high. You have 6.8 ozs./gal. of free cyanide, whereas for the metal content (2.2 ozs./gal.) a free cyanide content of not over 5 ozs./gal. would give better results. Before making any changes to the solution, however, you should have it analyzed.—G. B. H., Jr.

Analysis of Cadmium and Nickel Plating Solutions

Q. 1. In reference to the methods of analysis on page 48 of the 1938 Platers Guidebook, in standardization of the stock solution A, 10 grams of ammonium chloride are added to the cadmium solution just preceding titration. Is this addition also made to the sample of plating solution?

2. A white precipitate forms when titrating for chloride in a nickel solution. Near the end-point a drop from the burette turns red when it hits the solution, but a heavy white precipitate is still at the bottom of the flask which turns red about 10 minutes after the end-point. Is this precipitation characteristic of the titration?

A. 1. The addition of ammonium chloride is not necessary when analyzing the plating solution because during the analysis both ammonium hydroxide and hydrochloric acid are added. These additions furnish sufficient ammonium and chloride ions to obviate addition of ammonium chloride.

2. The white precipitation is characteristic of the titration. The theory of this analysis is that silver chloride is less soluble than silver chromate so that no precipitate of the latter will form while chloride is present in the solution. When all the chloride has been precipitated as silver chloride, the first excess drop of silver nitrate forms the red coloration due to silver chromate. The white silver chloride precipitate may turn red after some time due to the admixing of red silver chromate with it. —G. B. H., Jr.

Iron Plating

Q. Will you please answer the following questions regarding iron plating.

1. Of what material should the container be made?

2. Of what material should the heating coil be made?

3. Why should the anodes be bagged with pure African asbestos bags?

4. Is is necessary to replenish the solution as it is used, and if so, how are the additions made?

A. 1. A rubber lined tank may be used as the container. This is set inside of a wooden tank leaving a ¾" space between walls which is filled with a high melting point bituminous material.

Tank Specifications: To be made of No. 10 gauge metal with 3/16" hard rubber lining covering inside of tank and extending 2" over top sides. Rubber lining must be able to withstand slightly acid solutions at temperatures from zero to 212° F. and be bonded to the metal by means of a thin layer of soft rubber.

2. Use ordinary iron pipe to heat solution but this should be removed after the proper temperature is reached. If expense is secondary, a steam coil with tantalum sintered on the surface would be satisfactory.

3. Pure, blue asbestos cloth is recommended because it is the only fibrous material which has proved to be satisfactory and efficient. Glass cloth has been tried but without success.

4. Replenishment of the solution depends upon the operating conditions and the changes in the electrolyte brought about therefrom. Analysis of the solution readily informs a person what additions are necessary. Blum & Hogaboom's book "Principles of Electroplating and Electroforming" is a good informant on iron plating and analyses for the same.—Iron Plater.

METALLURGICAL DIGEST

SELECTED ABSTRACTS ON CASTING—ROLLING—PHYSICAL METALLURGY

Alloyed Zinc Sheet

Commercial zinc sheet may be of three types: (1) of commercial zinc with a purity from 98.5 to 99.0%; (2) high purity zinc of a purity from 99.5-99.99%; (3) alloyed zinc in which small amounts of copper, aluminum, magnesium, etc., are the added constituents.

Copper has a much greater uniform elongation than zinc and its relation may be ascribed to the different lattices of the two metals, copper being face-centered cubic and zinc being hexagonal close-packed.

Copper hardens during deformation while zinc stops hardening after a short deformation. The deep drawability characteristics of zinc may be increased by increasing the amount of non-uniform flow e.g. the necking of a tensile specimen. This non-uniform deformation can be increased by suitable alloying additions resulting in an increased total deformation, thus electrolytic zinc with 2% copper has a total elongation of 35%, whereas commercial zinc may have an elongation of only 18%.

Machining of Aluminum Alloys

Notes on the Machining of Aluminium and Its Alloys. By J. H. Dickin and G. A. Anderson. J. Inst. Metals, 1939, 65 (Advance copy).

On account of the high speed and ease with which they can be machined, aluminium and aluminium-base alloys are often more economical to use than other materials. Pure aluminium machines satisfactorily, but owing to its softness, attention must be paid to the design of the tools and the speed of cutting. With alloys, more normal tool shapes can be employed. Cast aluminium alloys have good machining properties, and in general, the harder the alloy the better is the finish obtained. For this reason, heat-treated alloys give very satisfactory results. Fine grain-size and freedom from pinholing are important factors.

For ordinary wrought alloy machining stock, alloys containing Mg_2Si have replaced copper-zinc-aluminium alloys, being capable of taking a very fine finish at moderate engine-lathe speeds. In high-speed automatic lathe work, these alloys present a difficulty in that they are not free-cutting. The curling of the cuttings causes them to foul the tools and renders their removal by means of the cooling medium almost impossible.

Leaded-brasses are free-cutting and, similarly, age-hardening copper-aluminium alloys containing lead additions are also free-cutting, but owing to segregation, the properties are not uniform and free-cutting is only obtained at relatively low speeds. The addition of tin to similar alloys gives free-cutting properties, but there is a difficulty in production, owing to hot-shortness. The addition of antimony with tin eliminates the low-temperature liquid phase responsible for this hot-shortness. Regarding the mechanism of free-cutting, the addition of elements forming separate phases is necessary, but this alone is insufficient and the type of structure must be controlled. The question of shape and finish of tools is important in most machining operations, including milling, turning, drilling, filing and sawing. Lubricants are not critical; for general work, paraffin mixtures are satisfactory. In high-speed work, it is important that low temperatures should be maintained, and for this purpose, soluble oil emulsions are used.

Creep of Lead Solders

The Creep Properties of Soft Solders and Soft-Soldered Joints. By W. A. Baker, J. Inst. Metals, 1939, 65 (Advance copy).

Chill-cast soft solders were subjected to long-time creep tests at room temperature and at 80° C. In the range of tin-lead alloys tested, the eutectic was most resistant to creep. The alloys of lower tin content, tinman's and plumber's solders, had much lower resistance to creep at both temperatures. Antimonial solders with antimony contents equal to 6% of their tin contents were two to four times as resistant to creep as the corresponding non-antimonial alloys.

Single-lap, soft-soldered joints on mild steel, copper and brass were subjected to prolonged shear stress at room temperature and at 80° C. The creep strength of the joint was determined by the creep properties of the solder film, the latter being dependent on the solder used and on the alloying, if any, with the material joined.

Physiological Aspects of Copper

Normal drinking water contains up to 0.5 mg./l. and, in some cases, more corrosive waters may contain up to 5 milligrams/l. Normally the amount of copper which goes into foodstuffs does not exceed 1 mg. per day which is far below the limit for endangering health, inasmuch as the total copper content that can be absorbed by man is about 20 mg. per day. The action of copper physiologically depends upon whether it enters an empty or a full stomach, and in the latter case, the copper is practically entirely absorbed by the vegetable pulp and is, therefore, eliminated.

Age-Hardening of Copper-Aluminum Alloy

The Age-Hardening of a Copper-Aluminium Alloy of Very High Purity. By Jean Calvet, Pierre Jacquet and Andre Guinier. J. Inst. Metals, 1939, 65 (Advance copy).

The age-hardening of a copper-aluminium alloy containing 5.2% copper was studied at 25°, 100°, 150°, 200°, 250° and 300° C. by hardness measurements, microscopic examination, and X-ray investigations. At high temperatures (250° and 300° C.), hardening, which is not very pronounced, is related to the precipitation of a new phase, having tetragonal symmetry, and oriented with respect to the crystals of the solid solution. This phase tends to disappear with prolonged aging, when $CuAl_2$ is slowly formed.

At low temperatures (25° and 100°C.), hardening is more pronounced. At 25°C. no evidence of precipitation can be found even after prolonged aging, and at 100°C., the first signs are only visible after 120 days. Monochromatic X-rays afford evidence of segregation of the copper atoms into minute plane layers, roughly 4 A. thick and 50 to 200 A. in length and breadth. These layers are parallel to the cube planes of the solid solution crystals, but are dispersed at random throughout the crystals.

At intermediate temperatures (150° and 200°C.), the two phenomena are superposed; at first the segregations of copper atoms are formed, and later the tetragonal phase is precipitated.

Anodizing of Aluminum

The Anodic Oxidation of Aluminium. By J. W. Cuthbertson. J. Inst. Metals, 1939, 65 (Advance copy).

The anodic oxidation of aluminium in a number of different electrolytes using alternating current electrolysis has been investigated with the aid of the cathode-ray oscillograph. The effect of the oxide barrier on the form of the current-time and current-voltage curves has been studied and is shown to depend on the constitution of the electrolyte and operating conditions. Owing to a capacity effect, the current and voltage are always out of phase during the whole or a part of each half-cycle. The current-voltage curve consequently is a closed loop, the area of which is proportional to the dielectric loss in the film. The results obtained suggest that, while the mechanism of anodic oxidation in chromic, sulphuric, and oxalic acid baths is similar, chromic acid solutions should produce the more satisfactory films.

ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—FINISHING—RUST PROOFING—LACQUERING

Patents of Interest to Electroplaters

Abstracted by

Joseph B. Kushner, Ch.E.

Removing Superficial Oxide from Metals or Alloys. By Samuel J. Blaut and Harold M. Lang. Fr. 837,126, Feb. 2, 1939.

The layer of oxide formed on chrome steel, rustless steel, chromium-nickel alloys, chromium alloys and other metals or alloys, during their manufacture, is removed by subjecting the metals to electrolytic treatment, in which the metals form the anodes, in baths containing H_2SO_4 which is present in sufficient amount to impart to the metals a partial passivity sufficient to prevent attack by the acid baths. For chrome steel, baths containing 30-80% of H_2SO_4 may be used.

Bright Dip for Zinc, No. 2,154,451, April 18, 1939. Granted to R. O. Hull, assigned to E. I. duPont de Nemours and Company, Inc.

The patent consists of a bright dipping and passivating solution for zinc and zinc plated coatings. In general, it contains an acidified hydrogen peroxide solution at a pH varying from 0.5 to 3.5. The concentration of the peroxide varies from 2 to 8% and the best pH value is in the vicinity of 1. The finish obtained by dipping zinc coatings into this soluton displays passivity to staining and can be handled without fear of marring its appearance.

Moreover, treated specimens seem to be more resistant to corrosion and tarnishing than untreated specimens.

The following formulae for typical bright dips are given:

I.	Hydrogen peroxide	4% H_2O_2 by weight
	Sulphuric acid	0.25% H_2SO_4 "

The object will be bright after a 15-second dip.

II.	Hydrogen peroxide	4% H_2O_2 by weight
	Hydrochloric acid	0.15% HCl "
III.	Hydrogen peroxide	4% H_2O_2 by weight
	Acetic acid	0.6% $HC_2H_3O_2$ "

Bright Dip for Cadmium, No. 2,154,455, April 18, 1939. Granted to R. J. Kepfer, assigned to E. I. duPont de Nemours and Company, Inc.

The patent consists of a bright dipping solution for cadmium containing hydrogen peroxide and sulphuric acid or a related acid, the ratio between the sulphuric acid and the peroxide being approximately one to four. If cadmium plate is dipped into one of the dilute oxidizing acids for the purpose of brightening, large amounts of cadmium are dissolved and destroyed. The bright dip proposed overcomes this difficulty.

Plated articles can be left in it for long periods of time without danger. The cadmium becomes uniformly bright, without stains or discolorations. After cadmium plated work has been dipped in this bath, it may be nickel plated if it is desired.

The ratio of peroxide to sulphuric acid is very important as the incorrect ratio of these two substances will bring about dull white, grey or black shades on the cadmium. Typical formulae follow:

I.	Hydrogen peroxide, 30%	9 oz. by weight
	Sulphuric acid, 66°Be	2/3 oz. "
	Water to make	1 gallon

Dip for 15 seconds.

II.	Hydrochloric acid, 23°Be	3%
	Hydrogen peroxide	2%
	Water	1 gallon
III.	Lactic acid	5% by weight
	Hydrogen peroxide	2% "

Dip for Passivation and Brightening of Cadmium, No. 2,154,468, April 18, 1939. Granted to F. P. Oplinger, assigned to E. I. duPont de Nemours and Company, Inc.

Oxidizing acids stain and discolor cadmium plates when used as bright dips. Hydrogen peroxide solutions do not stain such work. A typical dip is:

Hydrogen peroxide, 100 vol.	6 oz.
Sulphuric acid, con.	1 "
Water	1 gal.

Dip for 15 seconds.

Zinc Bright Dip, No. 2,154,469, April 18, 1939. Granted to F. P. Oplinger, assigned to E. I. duPont de Nemours and Company, Inc.

The patentee claims a method and solution for bright dipping zinc consisting of a combination of an etching agent and an oxidizing agent. The combination must not be too strong in etching agent as the etching agent will dissolve too much metal before the oxidizing agent has an opportunity to exert its brightening effect. Typical dips given by the author are:

I.	Sulphuric acid	2%-5%
	Hydrogen peroxide	2%-5%
II.	Sodium chlorate	2 ccs. per liter
	Sodium hydroxide	1%
III.	Sodium chlorate	2%
	Sulphuric acid	0.25%
IV.	Sodium nitrate	2%
	Nitric acid, con.	2 ccs. per liter

Improved Method for Depositing Tin, No. 2,156,427, May 2, 1939. Granted to J. P. Cooper and D. W. Light, assigned to International Smelting & Refining Company.

Patentees claim smooth, fine-grained, cathodic tin deposits can be obtained by subjecting a tin anode to electrolysis in an aqueous solution of a tar acid, pyrolygneous acid and a mineral acid. The ratio of the tar acid to the pyrolygeneous acid should be about one to two with enough sulphuric acid present to bring the total acid content to 125 grams per liter, computed as sulphuric acid. For a tar acid, the xylenol fraction or the cresol fraction may be employed, but the cresol fraction consisting of cresylic acid, is preferred. A general formula is as follows:

Pyrolygneous acid (from wood dist.)	12 grams per liter
Cresylic acid	6 "
Sulphuric acid	110-115 "
Tin (in stannous form)	20-35 "

Small amounts of glue or goulac.

The bath is recommended for the electrorefining of tin.

Bright Zinc Barrel Plating, No. 2,157,129, May 9, 1939. Granted to Viola Hoffman.

The patent consists of a method and solution for bright plating objects with a coating of zinc in a barrel plating machine. Usually objects that have been zinc plated in barrels do not come out bright. Cadmium presents a better appearance but cadmium is expensive to use. The patented solution produces zinc deposits that resemble cadmium in brightness. The use of sodium thiosulphate brings about this increased brightness and improves the throwing power of the barrel. The formula is given as follows:

Zinc cyanide	10 oz./gal.
Sodium cyanide	9 "
Sodium hydroxide	10 "
Sodium thiosulfate	¼ "

The solution is run at room temperature with 20 amperes and 6 volts.

Post Scripts

Notes at the Bridgeport Branch Meeting

Your reporter arrived too late to witness the baseball brawl between Bridgeport and New Haven players, and at the present writing has been unable to learn exactly who won.

John Oberender vociferously proclaimed New Haven as the winner, and *Herman Braun, George Wagstaff* et al. equally as vociferously proclaimed Bridgeport the winner. To add to the confusion, *John Charleson* said that he thought he was playing with the Bridgeport Branch and only found out that he was a traitor, playing with New Haven, until after the game was over. *Howard Rice* was arbitrator of balls and strikes and managed to survive the ordeal. *Gene Phillips* and *Ralph McCahan* (a ringer) tried to unsuccessfully emulate *Bucky Walters. Bob Leather's* red shirt was an added obstacle to pitching.

George Karl awarded a special hunting cap to *"Puritan" Gene Phillips,* to be used for hunting game, not golf balls.

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Johnny McFadden, the Irish tenor, subjected the picnickers to "When Irish Eyes Are Smiling" at the slightest provocation, and in one case his rendition was presented to an empty hall. Johnny always started off strongly but folded on the last few stanzas.

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Fred Norgren drove all the way from Syracuse to attend the picnic.

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Tom Haddow and *Bob Sizelove* were visitors from Newark.

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Bill Ehrencrona proved himself to be a leader in every sense of the word in plating, politics and at the beer barrel.

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At the Electrochemical Society's Convention

Members were able to combine business and pleasure at the Fall Convention with ample opportunity for seeing the World's Fair.

W. B. Stoddard, Jr., was introduced to us by *Dr. Louis Weisberg.* W. B. S. just returned from a three years' stay in Russia, where he had charge of plating for a large automobile manufacturer. Several interesting articles by him are scheduled for future M. I. issues

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We wondered who was discussing so intelligently the paper by *Dr. Perley* on the dropping mercury electrode. It turned out to be *Dr. Samuel Glasstone,* renowned English theoretical electrochemist, who is now associated with the Frick Chemical Laboratory, Princeton University. Somehow we had envisioned him as a robust Englishman such as *E. A. Ollard.*

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George Hogaboom was ably abetted by son *Byron* in discussions of the papers on electrodeposition. *Dr. Blum, Prof. E. W. Baker* and *Gustaf Soderberg* were conspicuously absent.

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Dr. Charles Kasper objected to the term "basis" metal instead of "base" metal, saying that "basis" was an ideological term and not an electrochemical term. *Prof. Fink* did not dispute that point but argued that it saved confusion with the regular meaning for base as applied to metals.

Dr. K. Schumpelt (Newark) and Louis Gale (Boston) reading about the whales seen by Floyd Oplinger and Ed. Christ.

Dr. Frank Jones showed that he still has an interest in plating by attending the convention, even though he is now engaged in research work on glass for Bausch & Lomb Optical Company at Mellon Institute. Dr. Jones was author of one of the first papers on the deposition of tungsten.

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Floyd Taylor also attended the convention to keep up his interest in electrochemistry even though he has retired from technical work.

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Report on the Annual Picnic of the Buffalo Branch of the A. E. S.

On September 9, the Buffalo Branch held its annual picnic. It was considerably augmented by members from Rochester, Binghamton, Syracuse, Elmira and Toronto.

We were honored by a visit from our Supreme President, *R. M. Goodsell,* and our Supreme Secretary, *W. J. R. Kennedy.*

The highlight of the day was the ball game between Rochester and Buffalo. *"Cyanide Bill" Schneider* had the precarious job of umpire with *Ves Gartland* on the bases. Buffalo led 4 to 1 at the end of the second inning. At this time, several slanderous aspersions were cast on the integrity of "Cyanide Bill" by Ray Bergholz and Gerry Lux (of the Rochester team). Rochester finally won by a score of 9 to 6. This remarkable comeback was due in no small way to the brilliant fielding of Jud Elster who displays all the grace and agility of a ballet dancer despite the fact that he has been unable to see his toes for years.

Buffalo has, however, promised to show Rochester the finer points of the game next year.

Despite unfavorable weather conditions the rest of the program was carried through in a very efficient manner.

As darkness fell the Rochester contingent was rounded up and finally sent safely home in their bus under the protective wing of Jud Elster.

The day was thoroughly enjoyable and as this was the first time that the Buffalo Branch had attempted anything on such a large scale, it augurs well for the future.

Many supply houses donated gifts suitable for prizes in the various sports events thereby contributing largely to the success of the outing.

Joe Ruff, the energetic President of the Buffalo Branch, deserves great credit for the outlining of such a pleasant program.

Yours very truly,
Roderick McGhee,
Secretary.

Interesting Personalities in the Electroplating Industry

Royal F. Clark, Sr.

Plater extraordinary, author, stamp collector and a thorough gentleman.

"Royal," as he is familiarly known among the members of the A.E.S., of which he is a charter member since 1909, was born in Trenton, N. J., May 30, 1881. His father, Col. Wm. S. Clark, was one of 13 children (7 boys and 6 girls), and was associated with his 6 brothers who owned and operated the Clark Brothers Lamp Brass & Copper Co., Trenton, where oil lamps were manufactured of glass and metal.

Their glass factory was located in Ellwood City, Pa. In later years, they purchased the factory of Swann & Whitehead Co., Trenton, also manufacturers of lamps and incorporated under the name of the American Lamp & Brass Co., entering into the manufacture of art metal lamps, gas and electric portable lamps. Col. Clark was superintendent of the factory which included seven large buildings, one of which was an iron and brass foundry.

Royal F. Clark, Sr.

After graduating from the Trenton High School in 1900, Royal, his mother, and sister were sent by Royal's father to Atlantic City, N. J. for a month's vacation, and upon his return started to work as an electrician's helper in Philadelphia, Pa., for the Quaker City Electric Co., at $4.00 per week. After paying his room rent (sharing it with a schoolmate who was employed in Philadelphia) and meals, he had just 50c left for ice cream sodas, and as he is a teetotaler, he did not need cash for tobacco, cigars, intoxicating liquors and "movies"! Well, there was no such "animal" in those days. What did he do with the balance of the cash? Why, he bought postage stamps for his stamp collection. He started stamp collecting in grammar school back in 1892, when the Chicago World's Fair was holding forth, and Royal wears as a watch-charm, a World's Columbian Exposition half dollar dated 1892, which has been delicately hand-sawed around each letter and insignia by a jeweler. Yes, he has had it gold plated as is proper for an electroplater.

After three months as an electrician's helper, Royal's father decided he needed him at his factory to install additional wiring for lighting and inter-departmental telephone communication. After completing this work, Royal was put into the plating department, where gold, silver, nickel, copper and bright brass were plated on cast iron lamp bases and spelter slush mold articles. This is where Royal learned to deposit the McKinley gold finish, which was secured from a bright brass solution. This color rivaled gold and unless the two colors were put side by side, one could not tell whether it was gold plated or not.

In 1904, the Clark Bros. retired from the lamp business and Royal went to Richmond, Va., where he worked in a job plating shop owned by Harris Flippen & Co. Here he had to do the polishing, plating, buffing, lacquering and sometimes deliver the work and collect the amount of the bill. From this time, 1904 up to 1939, he has been a foreman plater in the following cities: Philadelphia and Lancaster, Pa., Winsted, Conn., Allentown, Pa., Rochester, N. Y., Sumter, S. C., Columbus, O., New York City, Wellsburg, W. Va., Bridgeport, Conn., Plainfield, N. J., Baltimore, Md., Irvington, N. J., Wilkes-Barre, Pa., Cleveland, O., Cortland, N. Y., New Haven, Conn., Montclair, N. J., and now Ogdensburg, N. Y.

For 3½ years he was foreman plater at the Acme Shear Co., Bridgeport, where he operated 38 nickel plating tanks, plating 200 to 300 gross of shears and scissors each day. Then the Columbia Phonograph Co. at Bridgeport, employed him as general foreman of the matrix manufacturing department where he operated 1880 tanks of copper sulfate solution in which were deposited a shell of copper 27/1000" thick for the making of "master," "mother" and "stamper" records. The total capacity in gallons of these 1880 tanks (each hard rubber tank having a capacity of 20 gallons with one record in each tank) was 37,600 gallons, and roughly, one ton of copper was deposited every 24 hours. Each copper shell weighed approximately 1 pound.

Royal's thirty-nine consecutive years (as he has never worked at any other business but electroplating) has given him experience in various lines which include, lamps, job plating musical instruments, art metal novelties, tin lanterns, telephone parts, uniform regalia and steel swords for army and navy officers, oil cans, shears, scissors, graphophone master records, typewriter parts, rivets, bolts, washers, bag frames, soda fountain appliances, piano hardware, buckles, auto bumpers, trunk and casket hardware, automatic oven heat controls, auto hardware, cork screws, ice picks, bar and restaurant accessories, auto radio boxes or cabinets fabricated in steel.

Royal has been secretary-treasurer of the New York Branch, A.E.S., when it was known as the National Electroplaters' Association of U. S. and Canada, secretary Bridgeport Branch, Newark Branch, and president of the latter branch.

During these years of plating, stamp and coin collecting, he also found time to contribute articles for publication, to the *Metal Industry*, as follows: May 1908, "Bright Copper Plating"; May 1908, "Imitation Gold or McKinley Gold Solution"; Feb. 1909, "Three Wire System of Current Distribution for Electroplating"; July 1909, "Electrocleaner"; Nov. 1909, "High Density Nickel Solution"; Jan. 1910, "Overcoming Streaking Acid Copper Bath"; Feb. 1911, "Clouded Brush Brass and Copper Finish"; Dec. 1918, "Depositing Nickel on Cast Iron from a Hot Electrolyte."

In 1924, Royal revised a section on nickel plating which was published in the 9th edition of the book, "Electro-Deposition of Metals," by Langbein-Brannt, published by H. C. Baird & Co., New York City, as well as other sections in the book.

He has attended several of the A.E.S. conventions and taken an active part in the discussions there, and also at the regular meetings in Cleveland, Philadelphia, New York and Newark.

Royal has been married 35 years and has a daughter and a son, Royal, Jr., both married, and Jr. bound to perpetuate a Royal Clark, has a three year old son, Royal 3rd.

Mr. and Mrs. Clark, Sr. are now residing in Ogdensburg, N. Y. Royal is a member of the Masonic Fraternity for the past 20 years and is a member of Damascus Commandery No. 6, Newark, N. J.

Founders' Gold Medal Winners, Walter Pinner and Leslie Borchert

Walter L. Pinner, joint winner with L. E. Borchert of the Founders' Gold Medal of the A.E.S., was born in Montgomery, Ala., in 1901. After graduating from High School in

Walter L. Pinner

1918, he spent two years at the Case School of Applied Science at Cleveland, and graduated from the University of Michigan, Ann Arbor, in 1923 with a B.S.E. (chemical engineering). As a result of his thesis work at the University on copper plating, he was employed by the C. G. Spring and Bumper Co., Kalamazoo plant, as routine chemist. Mr. Pinner was transferred in 1924 to the Chicago plant, as plating superintendent, and in 1925 to Detroit as chief chemist of the C. G. Spring Bumper Company, retaining this capacity after the company became the General Spring Bumper Corporation, division of Houdaille-Hershey Corporation.

In 1931, Mr. Pinner resigned from this corporation and joined the D. L. Auld Company, Columbus, Ohio, where he received a liberal education in the plating and finishing of non-ferrous metals. In 1934, he again joined the Houdaille-Hershey Corporation in his former capacity and is continuing at present as chief chemist.

Mr. Pinner's publications, either alone or in conjunction with associates, include: "Bent Cathode Test for Chromium Plating"; "Rust Resistance of Chromium Plate"; "Cleaning Before Electroplating"; "Sodium Metasilicate, A New Industrial Alkali"; "Experiences in Evaluating Plated Coatings"; "Importance of Anode Corrosion in Electrodeposition of Nickel." He received the A.E.S. Medal in 1938, and the Founders' Gold Medal in 1939.

Apart from the foregoing, Mr. Pinner likes to play golf and seldom breaks 100.

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Leslie C. Borchert received his High School training in LaCrosse, Wisc., after which he attended the University of Michigan. He received his B.S. degree in chemical engineering in 1928.

Mr. Borchert started working in the Chicago plant of the C. G. Spring and Bumper Company, which is now the General Spring Bumper Division of Houdaille-Hershey Corporation. He began as an assistant chemical engineer with this company and assumed complete control of the plating operations in 1934.

He is a member of the American Electroplaters' Society and the Electrochemical Society, and has presented papers before the A.E.S. in Milwaukee and at the annual meeting in Chicago. He is married and resides in Chicago.

Leslie C. Borchert

George Knecht tagged for any eventuality and about to hoist a root beer.

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Phil Ritzenthaler, who has an interesting article in this issue on the effects of temperature on plated coatings, has become a farmer, at least, as an avocation. He now lives in West Allis, Wisc.

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A mountain man who rarely, if ever, visited a town of any size, came to a city with his son, traveling in a rattletrap car.

Climbing out on one of the main streets, the old man appeared fascinated by the pavement. He scraped his feet on the hard surface, and, turning to his son, remarked:

"Well, I don't blame 'em for building a town here. The ground is too darn hard to plough, anyhow."

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Nate Promisel corrected the editor on the editorial in the September issue on the use of compressed air, in which it was stated that momentum varied as the square of the velocity, whereas, as Nate rightly states, it varies linearly with the velocity, and kinetic energy varies with the square of velocity. Nate still evidently remembers his physics as well as chemistry.

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All Roads Lead to Bethlehem

Oct. 7—Leacrest Party as per the following letter:

"Dear Walter:

Thanks for your letter of August 14 and we have decided on Saturday, October 7 for the date of our next Leacrest Frolic, or Outing, or whatever you care to call it.

At a meeting of the Most Worthy and High Potentates this date was selected as we believe it would not interfere with any of the outings or functions of the American Electroplaters' Society, and we humbly request that you advise the clan that no invitation is necessary. This party is for anyone in our industry, and the more the merrier. Last Spring's record—162. Perhaps this Fall we will hit the 200 mark and please pray every Tuesday and Thursday that we may have a fair and beautiful day on Saturday, October 7.

Sincerely yours,
R. S. Leather."

Bob Leather and his Pekinese ready to play host Saturday, Oct. 7.

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What Is It the A. E. S. Has?

It has gone down in history, that show of elan,
By one of our members, who hitch-hiked to the Clan,
Which had met at Milwaukee, for learning and sport,
A meeting where good fellowship, made time seem so short.

Now history has been made again, by our esteemed Ray Goodsell,
And our Executive Secretary, Bill Kennedy, as well,
Who thumbed their way from Buffalo, in order to attend,
The picnic of Buffalo, Rochester and Binghamton men.

A literary genius, a real story could relate,
Of this spirit of pioneering, which is certain to make,
Our members attain, their full share of success,
By the working and striving for the old A. E. S.

To fix responsibility—
Inspired by *Bert Sage*
Verse (?) by *Ye Editor*

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Congratulations are in order to *Philip Sievering, Sr.,* for completing his 50th year in the metal finishing and plating industry; to *Wilfred S. McKeon* for being elected president of the *Century Fittings Company;* to the *Educational Committee* for their excellent work in publishing the Annual Proceedings.

Walter R. Meyer

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

New Fast-Drying Rack Coating

The Michigan Chrome Co., 6348 E. Jefferson Ave., Detroit, Mich., has recently introduced a new protective coating material to be used for insulating plating racks. The manufacturers state that this coating, known as "Miccrolite," can be applied faster and will air-dry much more quickly than the usual plating rack protective coatings. The dipping speed is approximately five times faster than that of other coatings, it is said. Under average drying conditions, one coat can be applied each hour. The seven coats recommended to prepare the racks for plating use can be applied in one day and the racks can be used the following morning.

This material has been developed as an all-purpose protective material for plating racks, used in any solution, or acid or in any process. It is not affected, it is claimed, through the complete cycle of plating, and is effective in all types of cleaning operations. It contains no pigments and is perfectly clear in appearance both before and after it is applied.

The coating is of a low viscosity, which permits the application of extremely thin, yet effective, coatings. According to the manufacturers, no thinner is required except for an occasional surface spraying when racks are being dipped, and it assures smooth, uniform coatings with practically no dripping of the material after the racks have been dipped. Webbing or pocketing between contact points is reduced to a minimum.

This material can be applied either by hand or machine dipping. It is applied directly on the metal surface of the rack, with no treatment necessary other than cleaning the surface to be coated. No tape or any special treatment is required. If a rack should become damaged in process, it is only necessary to touch up the damaged section, the patch becoming an integral part of the entire coating.

Nickel Brightener

An addition agent called "Nickel-Brite," is available for addition to any nickel solution of standard formula in order to produce a bright, lustrous deposit.

It is said that on small novelties and steel stampings which have a bright, clean surface before plating, color buffing and burnishing are entirely eliminated. It is claimed that Nickel-Brite works equally well in conveyors, plating barrels or steel tanks.

One-half pint is required for 100 gallons of solution, and the brightness of the deposit is used as an indication of the need for the periodic addition of nickel brightener.

For prices and other information, write the Wambaugh Chemical Co., Goshen, Ind.

New Machine for Flat Finishing

C. B. Larson, 27 Tuscan Rd., Maplewood, N. J., has designed a new machine to surface flat or similar parts, turning out, it is claimed, perfectly flat finishes at a high production rate.

The construction is said to be sturdy enough to be used for grinding, polishing or buffing. The attachment is arranged to be used in connection with an ordinary polishing lathe, preferably in pairs for each lathe, so that one operator controls the product of both spindle ends. By using two attachments on one lathe, one operator, it is reported, can practically double his hand production and at the same time differentiate the wheel grit, if desired. It is also claimed that one operator can handle two lathes using four flat polishing attachments with four different grit combinations, and the device can also be used singly so that the operator can finish an edge operation by hand, while the flat is being processed on the attachment.

The oscillating spindle is mounted on a balanced floating arm, which is equipped with depth-of-cut adjustment as well as pressure control. The "floating" feature can be eliminated when grinding with hard wheels. Spindle and all rotating shafts are mounted in anti-friction roller or ball bearings. The polishing spindle is driven by a three groove V sheave, which is mounted on the original lathe spindle, just as a polishing wheel is secured. The free end of the lathe spindle extends into (but clear of) the floating arm support bracket. This bracket is bolted to the lathe pedestal.

Machine for finishing of flat parts.

The reciprocating table is mounted on an individual heavy base, gear-driven, by a ¼ HP motor concealed in the base, which is said to be dust-proof. An easily removable cover provides access within.

The work table onto which the fixtures are secured, has a leveling adjustment, and to it are attached dust aprons protecting the slides, etc. The stroke of the table is power driven and a foot treadle combined with an electric switch starts and stops it, and at the same time automatically lowers and raises the polishing wheel from the work, leaving both hands free to remove and replace the work being processed.

Sisalin Buff Sections Said To Reduce the Cost of Finishing Aluminum

In a large aluminum processing plant in Detroit, Sisalin Sections are employed with tripoli composition to completely finish heat treated aluminum rods, tubing, and other parts. These sections are made of specially prepared sisal, a tough fibre, interleaved with alternate layers of muslin, bound together by various types of sewing.

Previously, these parts had been polished on a cloth wheel set up with No. 180 Turkish emery with tallow. During this operation the parts became hot and had to be cooled off before the buffing and coloring operation which followed.

By using the Sisalin Sections only the one operation was necessary, instead of three. The parts remained perfectly cool as very little pressure is required against the buff wheel.

The handling of the parts has now been reduced to a minimum. No polishing wheels have to be set up. No tallow is used and two extra lathes are made available by the elimination of two operations.

The savings on material and labor over the old method are estimated at 50% by the aluminum parts manufacturer. The Sisalin Sections are made by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies.

New All-Purpose Cleaner

Quigley Co., Inc., 56 West 45th St., New York City, have announced the development of their Annite red label cleaner, which is said to be a vegetable compound that contains no caustic, harmful alkalies or chemicals.

It is claimed to be free from abrasives, animal fats and inert fillers, and because of its neutral nature, repeated applications of the cleaner are stated not to injure any fabric or surface not affected by similar use of plain water.

The cleaner is soluble in fresh or salt water at any temperature, forms no sediment and is capable of forming suds in extremely hard water. Its cleaning action is described as being due to a highly active colloidal detergent which cleans by the physical process of emulsification.

Its use is recommended in concentrations varying from ¼ ounce to 2 ounces per gallon of water. It is recommended for use in mechanical devices and is suitable for general purpose cleaning, such as for floors, walls, lavatories, swimming pools, dishes, glassware, etc.

For further details and literature write the Quigley Co., Department M.I.

Special Design of Vapor-Liquid-Vapor Degreaser

For the fully automatic, economical cleaning of cylindrically-shaped parts, such as the stators and rotors that are used in electrical refrigerators, the Detroit Rex Products Company, 13005 Hillview Avenue, Detroit, Michigan, has developed and placed on the market a 1-dip Detrex Degreaser as shown in the illustration. This degreaser fits into the manufacturing and assembly line and does not require any operator to handle the work.

The conveyor on this machine is a two-strand type equipped with pendant fixtures for carrying the work to be cleaned. The cylindrically-shaped work is fed to the degreaser 6 units wide from a table equipped with guides, and the parts are released by a chain-driven, indexed feed mechanism which allows them to roll on the pendant-type fixtures; these fixtures being rigidly guided in both the loading and unloading position.

The cleaning cycle consists of two minutes in vapor, two minutes immersion in boiling solvent, followed by two minutes in the pure solvent vapors. As the work is carried out of the solvent vapors, it is perfectly clean, warm, and dry. At the exit position, the work is unloaded smoothly onto the unloading platform as the conveyor changes direction of travel and tilts the work fixtures. The loading and unloading tables are at opposite ends of the machine.

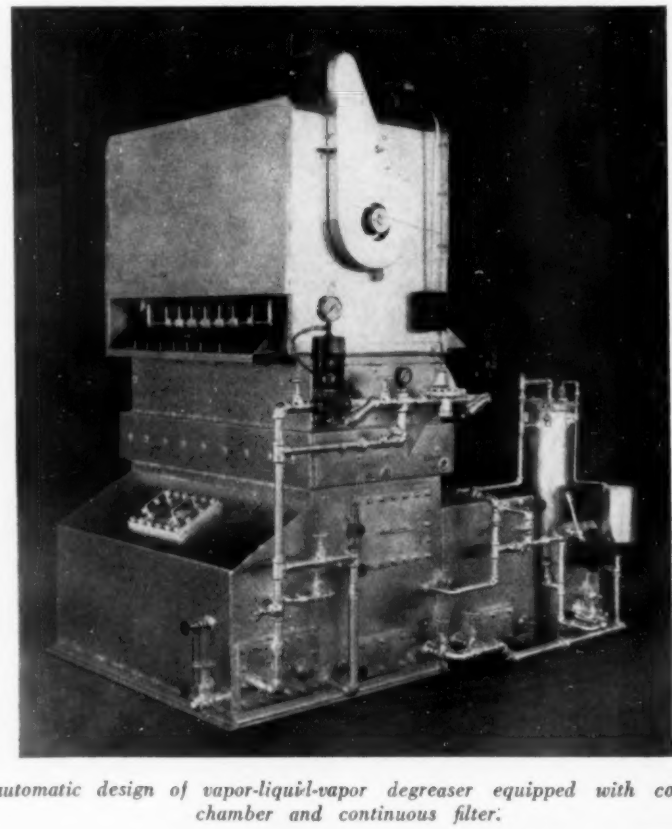
The solvent in the immersion boiling chamber is kept continuously clean by the use of an auxiliary concentrating chamber, the return flow of pure distillate from the wide water jacket condenser to the immersion chamber, and a continuous operating filter applied to the immersion chamber for the complete removal of insoluble matter that is removed from the work.

The concentrating chamber, which can be seen extending out under the unload end of machine, is heated with steam coils which are welded to a removable clean-out door. The clean solvent immersion chamber which can be seen on lower center section of photograph, is heated by a steam-jacketed bottom, that is equipped with a pressure relief valve. Both the concentrating and immersion chambers have access doors, clean-out doors, gauge glasses, and drain valves. The condensate from the collecting trough inside the machine beneath the water jacket condenser can be piped either to the immersion chamber or the clean solvent storage tank. This storage tank is of sufficient capacity to hold all of solvent from machine during distillation.

A motor-driven solvent transfer pump is used to transfer solvent from drum to machine, from storage tank to immersion chamber, and to continuously circulate the solvent from the immersion chamber through the continuous filter.

This degreaser is equipped with a direct acting, self-actuated vapor level control, by-pass piping, valve, strainer, steam gauge, and steam pressure reducer.

This design is manufactured in various sizes depending on production requirements.



Fully automatic design of vapor-liquid-vapor degreaser equipped with concentrator chamber and continuous filter.

Resin Cement

The Atlas Mineral Products Co., Mertztown, Pa., has developed a new impervious synthetic resin cement, "Korez," which is applied as a mortar and quickly sets by chemical action at room temperature to a dense, strong, jointing material, according to the manufacturers.

Being impervious and inert to all acids, except the highly oxidizing ones, and inert to oils, water and mild alkalies at temperatures up to 330° F., this resin cement, it is claimed, solved many difficult corrosion problems in steel plants, chemical plants, refineries and in the food industries.

Used as an acid-tight jointing material for acid-proof brick, "Korez" claims to have successfully solved corrosion and maintenance problems in construction of acid pickling tanks, acid neutralization and disposal equipment in the steel and allied industries.

Linings of this material have, it is reported, also proved to be of value for the handling of numerous corrosive mixtures in various chemical plants, and being non-porous they are particularly adapted to the construction of equipment for the recrystallization of salt solutions. They are not, it is said, affected by abrasion or turbulent liquids.

New Coatings for Magnesium Alloys Announced

The development of new protective and decorative coatings for magnesium alloys has recently been announced by The Dow Chemical Company.

According to Dow technicians, two of these coatings known as Treatment No. 7 and Treatment No. 8 surpass other known treatments in protecting magnesium alloys against salt water, and upon general atmospheric exposure result in satisfactory adhesion surfaces for subsequent paint systems. Since they introduce no dimensional change, the new treatments may be used on parts machined to close tolerances.

Treatment No. 7 is usually applied to Dowmetal parts after they have been machined. Dow research men claim that all surfaces, even deep holes, treat equally well. The treatment imparts a dark brown to black finish on most alloys, and may be used on all except Dowmetal M. It finds its greatest application in the aircraft field.

Treatment No. 8 may be used on all alloys and forms including Dowmetal M. It is said that this treatment does not affect machined dimensions and leaves machined surfaces with their original lustre. Complete treatment is obtained on all surfaces, including the bottoms of deep holes. Tidewater tests recently completed at Miami, Fla., show Treatment No. 8 to be superior to the chromium treatment in protection against salt water corrosion.

Another Dowmetal protective coating by means of which various colors can be produced, is known as Dow. No. 6. It is in reality a dye coating produced in water solutions at high temperatures and pressures. The coating can be furnished in colors ranging from yellow, red, blue, and green, to metallic lustres such as bronze and brass. Its greatest use is for decorative treatments and it may be used to protect parts which cannot be conveniently painted.

Some measure of success also has been attained in experimental electroplating of Dowmetal. Although this is not in commercial use at the present time, it appears to have great value in this direction for future.

Manufacturers' Literature

Air Heaters. Bulletin 74 outlines briefly the history of indirect air heating, giving information on the design and construction of the new "Despatch" heavy duty indirect air heaters. They are recommended for the following: baking ovens, space heating, dryers and dehydrators, curing ovens and kilns. Despatch Oven Co., Minneapolis, Minn.

Ajax Flexible Coupling Co., Westfield, N. Y., has appointed the *Urquhart Service Co.* 1501 Wynkoop St., Denver, Colo., sales representative of the company in the Colorado district. The principal base metal used is steel.

Amperehour Meters. Modern electroplating control with "Sangamo" amperehour meters is the subject discussed in this catalog, under the headings—Solutions, Cost Figuring Easy, Reduces Rejects, Precision Built, Acid Solutions, Alkaline Solutions, Plating Costs. Lasalco, Inc., 2822 Lasalle St., St. Louis, Mo.

Burgess-Parr Co., Freeport, Ill., has returned to active promotion of all Illium products with the presentation of new

rolled forms of Illium alloy. The following departments are operated: rolling, pickling, welding, grinding and sand-blasting. The principal base metal used is nickel-chromium.

Cement. Folder No. K-1 covers "Korez" an acid, water and oil-proof cement, which claims to have unusual properties and applications. Various uses given are: for chemical equipment; storage tanks, re-circulation tanks, etc.; tanks for the cleaning and pickling of metals; tanks for the electrolytic refining of metals; tanks for the handling of acid electrolytes; plating tanks; floors, subjected to continual washing, abrasion, acids, weak alkaline solutions, water, oils, fats, etc.; trenches, sump pits and drains; fume ducts, stacks, washers, and pointing of old brickwork. The Atlas Mineral Products Co., Mertztown, Pa.

Chemicals. This catalog of specialty chemicals covering emulsifying agents, glycol and glyceryl esters, synthetic waxes, etc., has been revised and brought up to date. In addition to the suggested formulae and useful tables contained therein, a complete index of materials classified according to industry, has been included; also some new materials recently introduced by the company. Glyco Products Co., Inc., 148 Lafayette St., New York City.

Chromium Plating. A well illustrated catalog showing applications of "Duro-Chrome," which is reported to increase wearing life, prevent galling and eliminate heat treating. Among these applications are: bevel gears, armatures, boring bars, drawing, and bending dies, cam shafts, burnishers, torch nozzles, bench lathe pulleys and bearings, rubber molds, Bakelite molds, etc. Duro-Chrome, a division of the Vacuum Can Co., 25 S. Hoyne Ave., Chicago, Ill.

Chromium Plating. "Duro-Chrome" checking list, which gives 557 ways in which this process is being used in 69 industries. Duro-Chrome, a division of the Vacuum Can Co., 25 S. Hoyne Ave., Chicago, Ill.

Cleaners. A handsomely bound anniversary brochure, entitled, "Oakite—Completing 30 Years of Service to Industry—1909-1939", covering the various industries where this cleaner is used, namely: steel, machine tools, automobiles, aviation, stampings, enameling and ceramics, food, baking, chemical, etc. Many fine illustrations are included. Oakite Products, Inc., 22 Thames St., New York City.

Floor Resurfacer. A folder devoted to "Rockflux," a combination of diabase, quartz, iron and volcanic ash, which is said to be a very tough material, wearing like iron, and impervious to grease, oil, lactic acid, etc. According to the manufacturers, it produces a permanently hard, smooth surface. Flexrock Co., 2300 Manning St., Philadelphia, Pa.

Furnaces. Bulletin No. 12 gives information on the 3KW converter, which is said to have a wide field of application in the laboratory and in commercial establishments, and dental laboratories have found it particularly useful for making dentures of stainless steel, gold, silver and platinum alloys. Furnaces for use with this converter, are said to be suitable for high temperature and general application heating; 2-pound and 4-pound furnaces for non-ferrous melting, and special furnaces are made from the size of a thimble up, for heating, melting, vacuum or high temperature work. Ajax Electrothermic Corp., Trenton, N. J.

Grinders. Bulletin No. 162 is devoted to the recently developed line of type BPA precision internal-external grinders. Information is given on this equipment, designed for application to lathe, planer, milling machines, etc. Belt drive and spindles mounted in precision bearings are featured. Standard Electrical Tool Co., 1938-46 W. 8th St., Cincinnati, Ohio.

Grinding Wheels. A catalog describing and illustrating abrasives, bonds, grinding wheel faces and speeds, wheels for lathe and planer tools, milling cutters and drills, etc. Norton Co., Worcester Mass.

Grinding Wheel Cements. A booklet containing information on "Nuglu," a liquid cold glue for setting up polishing wheels, belts and discs manufactured by J. J. Siefen Co., 5657 Lauderdale St., Detroit, Mich.

Lubricant. A folder on the "Lubriflush" method of bearing lubrication, which claims to allow clean lubricant to be introduced to the innermost recesses of the bearings. U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles, Calif.

Lubrication. This folder states that on June first the use of kerosene was inaugurated as a spindle lubricant for all grinding machines with plain bearing, automatically lubricated wheel spindles, by the

Norton Co., Worcester, Mass. With kerosene lubrication, this firm reports the spindle bearing can be set much closer and their temperature rises only about 10° F. above machine temperature compared with 50° F. for even a high grade of light spindle oil.

Metal Forming. "Niagara" slip roll forming machines are described and illustrated in Bulletin 77. Particular attention is invited to the trigger release arrangement which is said to permit easy removal of the finished cylinder. Niagara Machine & Tool Works, 637 Northland Ave., Buffalo, N. Y.

Nickel Alloys. This catalog describes briefly the general characteristics of "Ni-Resist," as being readily machinable when its chromium content is under 3%; it may be welded by the acetylene torch, using filler rod of the same composition and practice corresponding to that used on cast iron; it is non-magnetic. The corrosion-resisting properties of this alloy are discussed under the heading, "Method of Corrosion Testing in Sewage Disposal Plant." International Nickel Co., Inc., 67 Wall St., New York City.

Perfection Tool & Metal Heat Treating Co., 1740 W. Hubbard St., Chicago, Ill., recently acquired the rights to the "Nusite" hardening process, and is now applying this process to the treatment of cobalt high-speed steel, which is claimed to have great toughness and strength.

Pumps. Bulletin 313 contains information on the "Nash" glass centrifugal pump, which is said to have the mechanical advantages of metal and the chemical advantages of glass. Made of "Pyrex" brand heat and shock resisting glass, the pump impeller and casing are said not to be affected by temperatures up to 150° F. in standard design, and 200° F. in special design; hot acids or brine cooled liquids may be pumped with equal facility, it is claimed. The Nash Engineering Co., 203 Wilson Rd., South Norwalk, Conn.

Stoneware. Bulletin 404 is devoted to storage and mixing equipment for acids and corrosive chemicals, tanks, jars, pots, trays, and corrosion-resisting tank linings. A short write-up on installation and use of "Stoneware" vessels is included. The U. S. Stoneware Co., Akron, Ohio.

Tank Finishes. A folder recently published by the American Asphalt Paint Co., 43 E. Ohio St., Chicago, Ill., gives general instructions and surface preparations in applying tank finishes; how to paint metal, wood and concrete tanks, both interior and exterior surfaces; how to quickly estimate surface areas and amount of paint required on various size and style tanks and supporting structures. This firm manufactures "Valdura" tank finishes.

Welding. Thyratron-controlled G-E automatic arc-welding equipment for use with bare or lightly coated electrodes is discussed in GEA-3042A. Some of the outstanding features claimed are: metal deposited two to three times faster; electrode costs cut in half for equivalent deposition; fillets of equal strength with 25 per cent saving in time, 25 per cent saving in electrode costs; savings on butt welds and lap welds, etc. General Electric Co., Schenectady, N. Y.

Letters From Our Readers

Editor,
METAL INDUSTRY
Dear Sir:

In the July issue, there is printed a resume of the paper by Mr. C. E. Gardam on "Distribution of Deposits on Cup Shaped Articles." The statement is made in this resume that cobalt bright nickels give much poorer distribution than certain other nickel solutions.

On seeing this, it occurred to me that Mr. Gardam's experiments might have been made on solutions containing no boric acid, because we have found that boric acid has a pronounced effect on the throwing power of these solutions. Accordingly, I wrote Mr. Gardam and asked him if his solutions contained boric acid. He replied that the solutions he tested did not contain boric acid, and that he would look into the matter shortly.

It is to be hoped that the results of Mr. Gardam's investigation of the effect of boric acid in these solutions will be published. In the meantime, I would like to point out that cobalt nickel plating solutions made up in accordance with our recommended practice always contain boric acid, and the general experience is that they compare favorably in throwing power with other nickel plating solutions.

Very truly yours,
LOUIS WEISBERG, INC.
Louis Weisberg.

A Tribute to Philip Sievering, Sr.

Editor,
METAL INDUSTRY:

The group of those attending the Fall meeting of the Electrochemical Society who had the opportunity to visit the plant of Philip Sievering, Inc., saw one of the best equipped job plating shops and more diversified methods of electroplating and finishing of metals than on any previous visit to an electroplating plant.

To list all that was seen would be to cover almost every phase of electroplating. There were the polishing, buffing and plating of steel, brass, copper, zinc, aluminum, lead and antimony objects of almost every conceivable shape and description.

The metals deposited included brass, bronze, cadmium, chromium, copper, gold, nickel, rhodium, silver, tin and zinc. Then there were the special operations of metallizing and plating of non-metallic substances. "Jetallizing" to produce a black finish on steel; Korolac for covering plating racks; Alumilite for coloring aluminum; Alzak to produce a durable lustre on reflectors made of aluminum; the making of screen cloth by electrodeposition; ornamental and hard chromium; rhodium for protection of silver and jewelry from tarnishing; the deposition of metal on aluminum by a special process and other processes, which, in enjoyment of seeing so many things done on a large productive scale, were overshadowed.

This remarkable plant is under the guiding genius of Philip Sievering who in 1889 began a half century work of doing the best possible work, and thereby not alone having a path worn to his plant, but the necessity of growing to be one of the largest job plating shops, requiring four floors of several thousand sq. feet area—a remarkable monument to the untiring efforts of a man who did what he had to do, well.

The memory of that visit will long be the realization that an education in electroplating was had in a few hours. Few plant visits give as much pleasure, and none, greater courtesy.

Sincerely,
G. B. Hogaboom, Sr.

New Books

Chemicals of Commerce, by Foster Dee and Cornelia T. Snell. Published by D. Van Nostrand Co., Inc., New York City. Size 5½" x 8½"; 489 pages. Price $5.00.

This volume is intended as a source of information on chemicals of actual commercial production, and is not a chemical dictionary, which gives a brief description of all chemical compounds. Thus most of the compounds described are of commercial use.

The book explains the commercial and technical nomenclature regarding organic and inorganic compounds. It discusses commercial acids and bases, both organic and inorganic, and salts of acids.

There are many chapters on organic chemicals including discussions on alcohols, aldehydes, nitrogen compounds, fats, waxes, ethers, etc.

The authors have had years of experience in the commercial world and the book is flavored with their experience. The volume, however, is not free of typographical errors and occasional notice of errors in formulae was made, such as that for

SOME FEATURE ARTICLES IN THE NOVEMBER ISSUE

1. Properties, Heat Treatment and Finishing of Stainless Steel.
2. Gas Kettles for Hot Galvanizing.
3. The Protection of Silver by the Electrolytic Deposition of Beryllia.
4. Electroplating in U.S.S.R.

Four feature articles on organic finishing in the Organic Finishing supplement.

sodium sulfite. In addition, the use of commas for separating double salts or hydrates rather than the common use of periods, may lead to some confusion when several compounds are run together. The authors also were not consistent in the writing of chemical formulae, and for example, the formula of sodium acetate is given as $NaC_2H_3O_2$, whereas the formula for potassium acetate is printed as KO_2CCH_3. It would have been better in the reviewer's opinion to have written the organic metal compounds using the standard system for organic chemistry rather than attempting to write them with the metal symbol preceding the organic portion of the formula.

Any criticisms expressed are trivial in comparison with the high quality of the work, and this volume should find wide uses among chemists and industrial workers who either use or handle chemicals.—W. R. M.

Manual of Foundry Practice. By J. Laing and R. T. Rolfe. Second edition, revised and enlarged, 1939. Published by Chemical Publishing Co., Inc., New York. Size 8¾" x 5½"; 304 pages. Price $7.25.

This authoritative and comprehensive book on foundry practice should be of value to all those connected with the foundry industry, because, while the book deals with the basic principles of foundry practice, the publication proceeds to a comprehensive treatment of the advanced technique, and this should appeal to the student as well as to the foundry manager.

It seemed particularly necessary, for example, to deal systematically with those multifarious design problems which confront the engineer and the foundry man of today—problems which modern producing methods seem only to render increasingly complicated.

A notable feature is the inclusion of very full details of five different typical mixtures, progressively increasing in silicon content and suitable for various classes of castings. Here the information covers the uses, the mixtures employed, the typical compositions obtained, and the tensile, transverse and hardness test results on four bars of each of the S, M and L sizes of B.S.I. test bar, together with figures showing the variation in the carbon distribution between combined carbon and graphitic carbon for each size of bar. In the case of one mixture, micrographs are appended showing graphite only (x 50 diam.) and general structure (x 1,500 diam.) for each size of bar. Such information should be invaluable to the foundryman. In considering the melting of cast iron, a new section covers the control of carbon content in the cupola, while additional information is given regarding melting costs for the cupola and other units.

Contents: The Principles of Molding and Core Making; Core Making; Molding Tackle; Molding Technique; Plate and Machine Molding; Molding and Running in Relation to Design; Loam Molding; The Metallurgy of Cast Iron; The Melting of Cast Iron; Special Methods of Production-Chilled Cast Iron and Malleable Cast Iron; Non-Ferrous Founding; Appendix: Contraction of Castings.

Uses and Applications of Chemicals and Related Materials. Compiled and edited by Thomas C. Gregory. Published by Reinhold Publishing Corp., 330 W. 42nd St., N. Y. Size 9¼" x 6"; 653 pages. Price $10.00.

This volume provides a quick means of determining the uses and applications of over 5,000 important substances in more than 50 leading industries. In addition to presenting the uses of these substances, the book also gives valuable data on the patent status of these materials, and the corresponding synonyms and foreign names of the substances are given, particularly the German and French names.

Because of its wide range of materials and their industrial applications, and the conciseness with which the information is presented, this book will be invaluable to the following: the sales manager of a chemical company because it will inform him about (a) the alternative uses for his products, and will thus open up new fields for sales exploitation; (b) potential uses of new products, which may be entirely different from those he is selling, but which may displace his product almost overnight. An outstanding example of this is the incursion on the alcohol anti-freeze market recently made by ethylene glycol; (c) the possible markets for new products made available to him by technical research or mechanical improvements within his own organization: the salesman of chemicals, because it will enable him to (a) increase sales volume by canvassing new customers in other industries than those in which his product is used in greatest quantity; (b) to sustain sales volume in territory dominated by a competitor in his main line; (c) inform himself more thoroughly in both his own and other fields. In this way the salesman will make himself more efficient and can better meet the competition of

rivals the general manufacturer because he can quickly find (a) the raw materials now in use by all important industries, as well as substitutes recently introduced; (b) materials now in the proposed or development stage: the research director and his staff: patent attorneys, importers and exporters, libraries, teachers and students of all branches of chemistry, advertising agencies, dealers, trade associations.

Engineering Physical Metallurgy, by Robert H. Heyer. Published by D. Van Nostrand Co., Inc., New York City. Size 6″ x 9″; 538 pages. Price $4.50.

The author has endeavored to produce a simple treatment of the concepts of metals technology, and to adapt it to the instruction of non-metallurgical students.

Although a wide range of materials within the major divisions of physical metallurgy has been included, no attempt has been made to approach the completeness of a handbook or to offer a laboratory manual. Selection of the subject matter and data was guided by the basic principle represented, as well as by their value as specific information.

The book is beautifully illustrated and printed on a good quality of paper with excellent photomicrographs for illustration.

Mr. Heyer, the author, is an experienced metallurgist being employed in the Research Laboratories of the American Rolling Mill Company.

The book deals with the more practical aspects of metallurgy which include discussions on processing operations, including hot and cold reduction and fabrication, welding, heat treating, and machining, primarily from the metallurgical rather than from the operational viewpoint.

The literature references at the end of each chapter are particularly comprehensive and the entire volume bespeaks of thoroughness, both in a study of the literature and of details regarding the subjects discussed.

The book is recommended to metallurgical students, engineers who desire a knowledge of metallurgical processes, and to the professional metallurgist who wishes to broaden his knowledge of the metallurgical field. The book should have a unique place among our metallurgical literature.—W. R. M.

Associations and Societies

American Electroplaters' Society

Meeting of Research Committee

There will be a meeting of the American Electroplaters' Society Research Committee on Friday, October 13th, at the Hotel Pennsylvania, N. Y., at 9:30 A.M. All those who are interested are urged to attend this meeting.

There will also be a meeting of the Joint Committee of the A.E.S. and A.S.T.M. at the same place and time on Saturday, October 14th to which those interested are also invited.

It is to be hoped that there will be a good attendance at these meetings as there are matters of importance to this work to be discussed.

Semi-Annual Leacrest Stag Party

The semi-annual Leacrest party will be held at Bob Leather's farm in Bethlehem, Conn., October 7th from 1:00 to 8:00 P.M.

The activities will include trap shooting with exhibition and instruction, horseshoes, archery, baseball, quoits, etc. Tariff $1.00.

The party will be held rain or shine as there is ample shelter.

Foundry Equipment Manufacturers Association Announce Clinic at Annual Meeting

Arthur J. Tuscany, Penton Building, Cleveland, Ohio, Executive Secretary and Treasurer, Foundry Equipment Manufacturers Association, announces that the Annual Meeting of the Foundry Equipment Manufacturers Association will be held at the Greenbrier Hotel, White Sulphur Springs, West Virginia, Friday and Saturday, October 6th and 7th.

The meeting which was scheduled originally for earlier in the year was postponed among other reasons so that it might come during the fall season and permit meeting at a resort location.

In addition to handling such regular business as the election of three Directors to serve for the ensuing three-year period, the meeting will engage in a carefully prepared clinic of the business situation in the equipment field. In view of the fact that considerable importance attaches to employment in the capital goods industry, of which equipment is a very definite part, it is felt that careful consideration of the entire question from the standpoint of members' individual activity, plans and prospects for the future well justifies the holding of a clinic on this subject.

All manufacturers of equipment used in

the foundry are cordially invited to attend and participate in the various discussions as well as enjoy the social features, including a golf tournament which will be arranged.

Obituaries

Alfred M. Pratt

Alfred M. Pratt, general superintendent for John Hassall, Inc., wire nail manufacturer, Brooklyn, N. Y., died of a heart attack at his home in Whitestone, Queens, on May 27, aged 43 years.

William F. Schultheiss

William F. Schultheiss, president and founder of the Public Service Brass Corp., Los Angeles, Calif., died recently at his home in San Marino, Calif.

Loran J. Harvey

Loran J. Harvey, general foreman of the West Lynn, Mass., plant of the General Electric Co., for thirty-nine years, died at his home in Swampscott, Mass., on Aug. 24th. Mr. Harvey served in the Spanish War in Cuba as lieutenant.

Lawrence J. Bradford

Lawrence J. Bradford, treasurer of the Lukenheimer Co., Cincinnati, Ohio, passed away suddenly in his home at Cincinnati, August 21st. He was 54 years old.

Edwin Hewitt Brown

Edwin Hewitt Brown, 60 years old, a director of the Bohn Aluminum & Brass Corp., Detroit, Mich., and former vice-president and treasurer of the General Aluminum & Brass Mfg. Co., was buried August 19, after services at Grosse Pointe, Mich. Mr. Brown was graduated from Yale University in 1901.

Charles Barndt

Charles Barndt, 63, vice-president and general manager of the former Hamilton Metalplane Co., Milwaukee, Wisc., was killed in an automobile accident in Cleveland on August 27th.

Personals

Dr. R. E. Wilson to Receive Medal

The Chemical Industry Medal of the *Society of Chemical Industry* will be presented to *Dr. Robert E. Wilson*, President of Pan American Petroleum & Transport Company, at a joint meeting of the American Section of the Society of Chemical Industry and the American Chemical Society on November 10, 1939, with *Dr. Wallace P. Cohoe* presiding. The medal is awarded annually for valuable application of chemical research to industry and will be given this year to Dr. Wilson in recognition of his research studies on such varied subjects as flow of fluids, oiliness, corrosion, motor fuel volatility, clay and glue plasticity, and humidity, and in recognition of his industrial contributions in the use of tetraethyl lead, petroleum hydrocarbon cracking, and adoption of chemical engineering principles by the oil industry.

The meeting will be held at The Chemists' Club, 52 East 41st Street, New York City. Details as to speakers, subjects of addresses, etc. will be announced later.

David R. Calhoun has been appointed manager of the Industrial Div. of the Wilkening Mfg. Co., Philadelphia, Pa., manufacturer of the Pedrick heat-shaped piston rings. During the last two years, Mr. Calhoun has been responsible particularly for service engineering in connection with fields sales. He will be succeeded in that position by *Webb Pedrick*. The company operates the following departments: grinding, sand-blasting, cleaning and tumbling. The principal base metals used are bronze, aluminum and cast iron.

Joe C. Danec, chemical engineer, has recently been added to the technical staff of Battelle Memorial Institute, Columbus, Ohio, according to an announcement by *Clyde E. Williams*, director. He has been assigned to the division of process metallurgy.

Mr. Danec is a graduate of Lafayette College, Easton, Pennsylvania, and a member of American Society for Metals and the American Chemical Society.

John S. Bartek, formerly chief engineer of the Modern Tool Works, Rochester, N. Y., has been added to the Engineering Staff of the Pioneer Engineering & Manufacturing Co., 31 Melbourne Ave., Detroit, Mich. Mr. Bartek was with the Pioneer Engineering & Mfg. Co., previous to his connection with the Modern Tool Works and returns as a specialist in threading problems.

Wilfred S. McKeon Becomes President of the Century Fittings Company

Wilfred S. McKeon has been appointed president by the directors of the Century Fittings Co., Greensburg, Pa., to succeed the late *Wm. J. Burkart.*

It is believed that under his able presidency the Century Fittings Co. will continue to forge right ahead. Since Mr. McKeon's election, the corporation has received the largest order of history. This firm manufactures bronze solder fittings, and owns a patent on a lock fitting on

Wilfred S. McKeon

which it is expected to get into production during the coming year.

Mr. McKeon is a member of the Greensburg Civic and Business Association and president of the Sulphur Products Co., Inc. He has cancelled a three-months trip into Mexico, the Canadian Northwest and Northeast in order to give the necessary attention to his new duties.

William H. Dunn, comptroller and assistant treasurer of Raybestos-Manhattan, Inc., Passaic, N. J., was elected secretary of the corporation at a meeting of its Board of Directors in New York on July 19. He succeeds as secretary the late *Morton F. Judd,* general manager of the Raybestos Division of Bridgeport and Stratford, Conn., who recently died.

Wayne Mendell has been appointed to supervise the sales activities of the Tolhurst Centrifugal Division and other divisions of American Machine and Metals, Inc., in the Chicago area, with headquarters at 35 East Wacker Drive. Mr. Mendell was formerly president of the Fletcher Machinery Corporation, and vice-president and general sales manager of U. S. Hoffman Machinery Corporation.

Warner B. Day, manager of the Chase Brass & Copper Company, Inc., at 411 D. Street, South Boston, is now heading the Non-Ferrous Metals group of the Greater Boston Annual Maintenance Appeal. Plans are being completed for the campaign which will start during the early days of October.

In this group *David H. Munroe,* of the same firm will act as vice chairman. Other sub-chairmen and leaders will aid Mr. Day.

Mr. Day is a World War veteran, lives in Hingham, and has been interested in the Salvation Army since the days among the French poppies.

Clarence S. Parker has recently completed fifty years of continuous service with the Revere Copper and Brass, Inc., New Bedford Division. The company presented him with a sterling silver plaque, suitably engraved, at a dinner held by the Revere Copper and Brass Foremen's Association, held in the New Bedford Hotel on May 26, New Bedford, Mass. The plaque carried the following inscription: "Clarence S. Parker, 1889-1939 from fellow workers who have benefited by his advice in their work and personal affairs many times during his 50 years' service with Revere Copper and Brass Inc." Presentation of the plaque was made by *F. J. Carrell,* production manager, who has himself served in the company's organization for forty years. Mr. Parker started as an assistant to the foreman in the cast shop and yellow metal mill at Taunton, Mass., on May 1, 1889. Through a series of promotions he was elevated to the position of superintendent of both the Taunton and New Bedford plants in 1920.

He is enjoying excellent health at the age of 70, and is at present serving in an advisory capacity to the Revere Mill at Taunton.

Verified Business Items

The General Electric Vapor Lamp Company of Hoboken, N. J., has been merged with the Incandescent Lamp Department of General Electric Co., as announced by *Charles E. Wilson*, executive vice-president of the company, and will be known as the Lamp Department of the above firm.

The Board of Directors of *Union Carbide and Carbon Corp.*, has approved an agreement for the acquisition by Carbide of all the assets of *Bakelite Corp.* Carbide is a producer of chemical raw materials and Bakelite a user of chemicals in its converting activities. Bakelite Corp. has been active in the manufacture and distribution of thermosetting plastics, principally of phenolic types. Over a quarter century ago *Dr. L. H. Baekeland* made his discovery which gave to the world a new material, called "Bakelite" plastic.

N. A. Woodworth, formerly president of the Ex-Cell-O Corp., Detroit, Mich., has formed a new company under the name of *N. A. Woodworth Co.*, 9111 Schaefer Highway, Detroit, Mich. Associated with Mr. Woodworth are *E. W. LaMonte*, previously with the Swartz Tool Products Co. and *J. F. Benner*, formerly of the Partool Machine Co. The N. A. Woodworth Co., has acquired the plant and facilities of the Partool Machine Co. The activities of the company in the beginning will be directed toward precision tool and machine work, as well as machine tool work.

Edwin H. Peirce has been appointed superintendent, rod and wire department, Portsmouth works of the Wheeling Steel Corp., Wheeling, W. Va. Prior to this appointment Mr. Peirce for 20 years was associated with the American Steel & Wire Co., at its New England plants, as chief metallurgist, superintendent of New Haven works, and later superintendent of the South works at Worcester. The following departments are operated: rolling, drawing, pickling and galvanizing. The principal base metal used is steel.

C. Donald Dallas, President of Revere Copper and Brass Incorporated, today announced the appointment of *R. Carson Dalzell* as Technical Advisor to Revere's Baltimore Division, with headquarters at 1301 Wicomico Street, Baltimore, Md.

Mr. Dalzell graduated from Johns Hopkins University in 1927 with degree of Bachelor of Engineering in electrial engineering.

He then entered the Graduate Engineering School of Harvard University, 1927; received the degree of Master of Science in non-ferrous metallurgy, 1928; received the degree of Doctor of Science in metallurgy, 1929. Metallurgical studies and research were conducted under Professors Albert Saveur and Arthur E. Wells.

Upon completion of work at Harvard in 1929, Dr. Dalzell entered the Central Research Laboratory of the American Smelting and Refining Company at Perth Amboy, N. J., where he remained until 1931. Upon his resignation from the American Smelting and Refining Co. in 1931, Dr. Dalzell was engaged by G. H. Clamer of the Ajax Metal Co., Philadelphia, for a period of one year on process development. Upon completion of his work there, he engaged in general metallurgical consulting work, at the same time representing Charles Englehard, Inc., in Maryland, Delaware and District of Columbia.

From 1933 to 1937 Dr. Dalzell was employed by the American Oil Co., Baltimore, Md., resigning to come with Revere on September 15, 1937.

G. S. Crane, vice-president in charge of sales and engineering for Cutler-Hammer, Inc., Milwaukee, Wisc., has announced the appointment of *E. W. Seeger* as manager of the Development Department, and *P. B. Harwood* as manager of Engineering Development for the company. Mr. Seeger was formerly in charge of the Production Engineering Department and will now become responsible for the company's development activities. Mr. Seeger joined the company in 1913 and since that time has been engaged in various engineering activities of the company, advancing to the position named which he held until his recent appointment. He is a Fellow of the American Institute of Electrical Engineers, a member of the Engineers' Society of Milwaukee and for some time now has been quite active on the Codes and Standards Committee of the National Electrical Manufacturers Association. Mr. Harwood has been with the company for over twenty years, serving in the Engineering Department, after which he was

made assistant supervisor in charge of steel mill control, then general supervisor in charge of engineering. Following this he was made assistant in charge of Production Engineering Dept., a position he held until his present appointment. Mr. Harwood is a member of the American Institute of Electrical Engineers as well as the Engineers' Society of Milwaukee, and is author of numerous articles on electrical engineering subjects. He has recently completed a text book dealing with the use of motor control for electric motors.

Porter-Cable Machine Company, Syracuse, N. Y., manufacturer of portable and stationary sanding and sawing machines, has added 90,000 sq. ft. to its manufacturing facilities through the purchase of adjoining land and buildings. The new manufacturing space will be occupied at once as the increasing business has outgrown the present facilities. The plant now has frontage on four streets, railroad siding and ample storage facilities. Departments: grinding, polishing, degreasing, cleaning and buffing. Principal base metals used: steel and aluminum.

Standard Steel Spring Company Has World's Largest Nickel Plating Tank

The Standard Steel Spring Company has recently completed the largest nickel plating tank in the world. The operating volume of the new tank is 27,500 gallons. The tank is fabricated of 3/8 inch steel plate lined with 1/4 inch of rubber. The inside dimensions of the tank area: length 67 feet 7 inches; width 6 feet 10 inches; depth 8 feet 3 inches. The weight of the nickel anodes in the tank is 33,000 lbs. The total value of the solution and the anodes is about $26,000.00. The temperature of the solution is automatically controlled and the solution is continuously filtered. The connected generator capacity is 25,000 amperes at 6 volts. This tank is used in nickel plating automobile bumpers.

The Standard Steel Spring Company, Coraopolis, Penna., has also recently introduced a new pore-free coating, "Corronite." Data on this pore-free metallic coating will be made available for the first time at the Metal Show in Chicago, October 26-30.

Aluminum Co. Expands Laboratory

Greater facilities for research in aluminum will be available upon completion of the additions which are at present being made to the Aluminum Research Laboratories at New Kensington.

The building program will include a two-story addition to the large testing laboratory for the purpose of housing a new testing machine, a one-story extension to the present shop building, and a three-story extension to the main building. The increase in floor space will amount to 15,000 sq. ft., and will bring the total laboratory floor space to 71,000 sq. ft.

When the present buildings were erected about 10 years ago, they were built with eventual expansion in mind. The finished structure was to be in the form of a hollow square, with some buildings in the center court. The front of the square, parts of two wings, and court buildings were built at that time.

The three-story extension to the south wing of the present building will be divided in the following manner: the ground floor will be occupied by offices of the physical testing division and part of the instrument shop; the first and part of the second floor will provide new quarters for the patent division; the remainder of the second floor will be used for additional laboratory space.

The space in the main building, vacated by the contemplated changes, will be used for rearrangement and expansion of other departments.

The new testing machine, to be installed in the two-story addition, will be able to exert a pressure of 3,000,000 pounds in compression, and 1,000,000 pounds in tension. It will be one of the largest machines of its kind in the country and ten times as large as the largest testing machine now in use at New Kensington.

The entire expansion program, begun during the summer months, will be completed by January 1.

Blaw-Knox Company, Pittsburgh, Pa. today announced the appointment of *Lawrence E. Joseph* as executive officer in charge of its Blaw-Knox Division. Mr. Joseph succeeds *R. F. McCloskey, Sr.*, a company vice president, who was placed in charge of the development of new products for the entire corporation.

Mr. Joseph, until the first of this month, was manager of the National Automatic Tool Company, Richmond, Indiana. Prior to that connection he was a vice president of the Liggett Spring & Axle Company, and previously was engaged as a consulting engineer.

Metal Prices

Due to the rapid changes in metal prices as a result of the war, the metal price page is being discontinued.

Supply Prices, September 25, 1939

Anodes

Prices, except silver, are per lb. f.o.b., shipping point, based on purchases of 2,000 lbs. or more, and subject to changes due to fluctuating metal markets.

COPPER:	Cast	21⅞c. per lb.
	Electrolytic, full size, 16⅞c.; cut to size	16⅞c. per lb.
	Rolled oval, straight, 17⅝c.; curved	18⅝c. per lb.
BRASS:	Cast	19¾c. per lb.
ZINC:	Cast	11¼c. per lb.
NICKEL:	90-92%, 16" and over	.45 per lb.
	95-97%, 16" " "	.46 per lb.
	99%+cast, 16" and over, 47c.; rolled, depolarized, 16" and over, 48c.	
SILVER:	Rolled silver anodes .999 fine were quoted from 49c. per Troy ounce upward, depending on quantity.	

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P. l.c.l., drums	lb.	.06¼
Acid, Boric (boracic) granular, 99.5%, bbls.	lb.	.053-.059
Chromic, 99%, 100 lb. and 400 lb. drums	lb.	.16¾-.17¼
Hydrochloric (muriatic) Tech., 20°, carboys	lb.	.027
Hydrochloric, C.P., 20°, carboys	lb.	.08
Hydrofluoric, 30%, bbls.	lb.	.07-.08
Nitric, 36°, carboys	lb.	.06
Nitric, 42°, carboys	lb.	.075
Oleic (Red Oil), distilled, drums	lb.	.09-.10
Oxalic, bbls. l.c.l.	lb.	.12-.14
Stearic, double pressed, distilled, bags	lb.	.12½-.13½
single pressed, distilled, bags	lb.	.12-.13
triple pressed, distilled, bags	lb.	.15¼-.16½
Sulphuric, 66°, carboys	lb.	.025
Alcohol, Amyl, l.c.l., drums	lb.	.15-.165
Butyl-normal, l.c.l., drums	lb.	.085
Denatured, S.D. No. 1, 190 pf., bbls., works	gal.	.305-.315
Diacetone, pure, drums, l.c.l.	lb.	.095
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.385
Propyl-Iso, 99%, l.c.l., drums	gal.	.41
Propyl-Normal, drums	gal.	.70
Alum, ammonia, granular, bbls., works	lb.	.0315
Potash, granular, bbls., works	lb.	.034-.037
Ammonia, aqua, 26°, drums, carboys	lb.	.02¼-.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls.	lb.	.05-.075
Sulphate, tech., bbls.	lb.	.035-.05
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55-.58
Sulphocyanide (thiocyanate), com'l, drums	lb.	.16
Antimony Chloride (butter of antimony), sol., carboys	lb.	.13-.153
Barium Carbonate, ppted., l.c.l., bags, works	lb.	.03
Benzene (Benzol), pure, drums, works	gal.	.21
Butyl Lactate, drums	lb.	.225
Cadmium Oxide, l.c.l., bbls	lb.	.60-.70
Calcium Carbonate (Ppted. chalk), U.S.P.	lb.	.05¾-.075
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05¾-.06
Carbon Tetrachloride, l.c.l., drums	gal.	.73
Chrome, green, commercial, bbls.	lb.	.22
Chromic Sulphate, drums	lb.	.26¼
Cobalt Sulphate, drums	lb.	.59
*Copper, Acetate (verdigris), bbls.	lb.	.25
Carbonate, 53/55%, bbls.	lb.	.14¾-.16
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, Tech., crystals, bbls.	lb.	.05
Cream of Tartar (potassium bitartrate), crystals, kegs	lb.	.26¼
Crocus Martis (iron oxide) red, tech., kegs	lb.	.07
Dibutyl Phthalate, l.c.l., drums	lb.	.195
Diethylene Glycol, l.c.l., drums, works	lb.	.155
Dextrine, yellow, kegs	lb.	.05-.08
Emery Flour (Turkish)	lb.	.07
Ethyl Acetate, 85%, l.c.l., drums	lb.	.066
Ethylene Glycol, l.c.l., drums, works	lb.	.17-.20
Flint, powdered	ton	30.00
Fluorspar No. 1 ground, 97-98%.	ton	$60.00
Fusel Oil, refined, drums	lb.	.125-.14
*Gold, Chloride	oz.	$18¼-23
Cyanide, potassium 41%	oz.	$15.45
Cyanide, sodium 46%	oz.	$17.10

*Subject to fluctuations in metal prices.

Gum, Arabic, white, powder, bbls.	lb.	.125-.14
Sandarac, prime, bags	lb.	.50
Hydrogen Peroxide, 100 volume, carboys	lb.	.20
Iron Sulphate (Copperas), bbls.	lb.	.016
Lead, Acetate (Sugar of Lead), bbls.	lb.	.10-.12¾
Oxide (Litharge), bbls.	lb.	.125
Magnesium Sulphate (Epsom Salts), tech., bag	lb.	.018
Mercury Bichloride (Corrosive Sublimate)	lb.	$1.58
Mercuric Oxide, red, powder, drums	lb.	$2.66
Nickel, Carbonate, dry, bbls.	lb.	.36-.41
Chloride, bbls.	lb.	.18-.22
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin	lb.	.05-.06
Perchlorethylene, drums	lb.	.08½
Phosphorus, red	lb.	.42
yellow	lb.	.55
Potash, Caustic, 88-92%, flake, drums, works	lb.	.07¼-.075
Potassium, Bichromate, crystals, casks	lb.	.09¼
Carbonate (potash) 98-100%, drums	lb.	.06¾
Cyanide, 94-96%, cases	lb.	.525
Pumice, ground, bbls.	lb.	.03
Quartz, powdered	ton	$30.00
Quicksilver (Mercury) 76 lb. flasks	flask	$90.00
Rochelle Salts, crystals, bbls.	lb.	.21¼
Rosin, gum, bbls.	lb.	5.25-7.75
*Silver, Chloride, dry, 100 oz. lots	oz.	.33¾
Cyanide, 100 oz. lots	oz.	.34-.39½
Nitrate, 100 oz. lots	oz.	.29¼
Sodium Carbonate (soda ash), 58%, bbls.	lb.	.0235
Cyanide 96%, 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake	lb.	.0355
Hyposulphite, crystals, bbls.	lb.	.035-.065
Metasilicate, granular, bbls.	lb.	.0315
Nitrate, tech., bbls.	lb.	.029
Phosphate, tribasic, tech., bbls.	lb.	.027
Pyrophosphate, anhydrous, bbls., l.c.l.	lb.	.0595
Sesquisilicate, drums	lb.	.0405
*Stannate, drums	lb.	.33-.35
Sulphate (Glauber's Salts), crystals, bbls., works	lb.	.0135
Sulphocyanide, drums	lb.	.30-.35
Sulphur, Flowers, bbls., works	lb.	.037-.0410
*Tin Chloride, 100 lb. kegs	lb.	.37½
Toluene (Toluol), pure, drums, works	gal.	.27
Trichlorethylene, drums	lb.	.08½
Tripoli, powdered	lb.	.03
Wax, Bees, white, bleached, slabs 500 lbs.	lb.	.38-.40
Bees, yellow, crude	lb.	.28-.30
Carnauba, refined, bags	lb.	.38-.40
Montan, bags	lb.	.21-.22
Spermaceti, blocks	lb.	.24-.26
Whiting, Bolted	lb.	.025-.06
Xylene (Xylol), drums, works	gal.	.31
Zinc, carbonate, bbls.	lb.	.14-.15
Cyanide, 100 lb. kegs	lb.	.33
Chloride, granular, drums	lb.	.06
Sulphate, crystals, bbls.	lb.	.04